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THE AMERICAN JOURNAL OF ROENTGENOLOGY
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LESIONS IN AND ABOUT THE SECOND PORTION OF THE DUODENUM*

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THE second portion of the duodenum, known as the descending or vertical portion, is retroperitoneal in location and extends from the level of the first lumbar vertebra downward along the right side of the vertebral column as low as the upper border of the body of the fourth lumbar vertebra. It bears a constant relationship to several important anatomical structures in this region and, because of this, a careful study of the second portion of the duodenum in obscure lesions of the upper abdomen may prove of definite diagnostic value. All too frequently the greater part of the examiner's attention is focused upon the stomach and first portion of the duodenum, the so-called "cap" or bulb, with less attention being given to the second and third portions of the duodenum.

No intelligent interpretation of changes involving the second portion of the duodenum can be made without a good knowledge of the anatomy of this region. It is likewise axiomatic that adequate roentgen examination of this portion of the duodenum requires studies in the right oblique and right lateral projections as well as in the posteroanterior view.[6,7] In the right lateral projection the pylorus lies between the cardiac portion of the stomach and the spine with the duodenal bulb immediately above it. From here, the course of the duodenum is backward, and at the superior angle it bends downward, paralleling the spine in front of the right kidney and bending upward toward the left side at the inferior angle in front of the spine; below the body of the pancreas it joins the jejunum. Thus in the lateral position the duodenum is presented in its true perspective, describing a loop within which the head of the pancreas is enclosed.[7] The distance between the descending duodenum and spine varies, being greater in the sthenic than the asthenic individual.

The superior angle of the duodenum is surrounded by the neck of the gallbladder on the right, by the cystic and hepatic ducts above, and by the common bile duct on the left. This tubular structure resembles a horseshoe with the open end directed downward toward the head of the pancreas and gallbladder respectively, forming an almost closed ring which practically encircles

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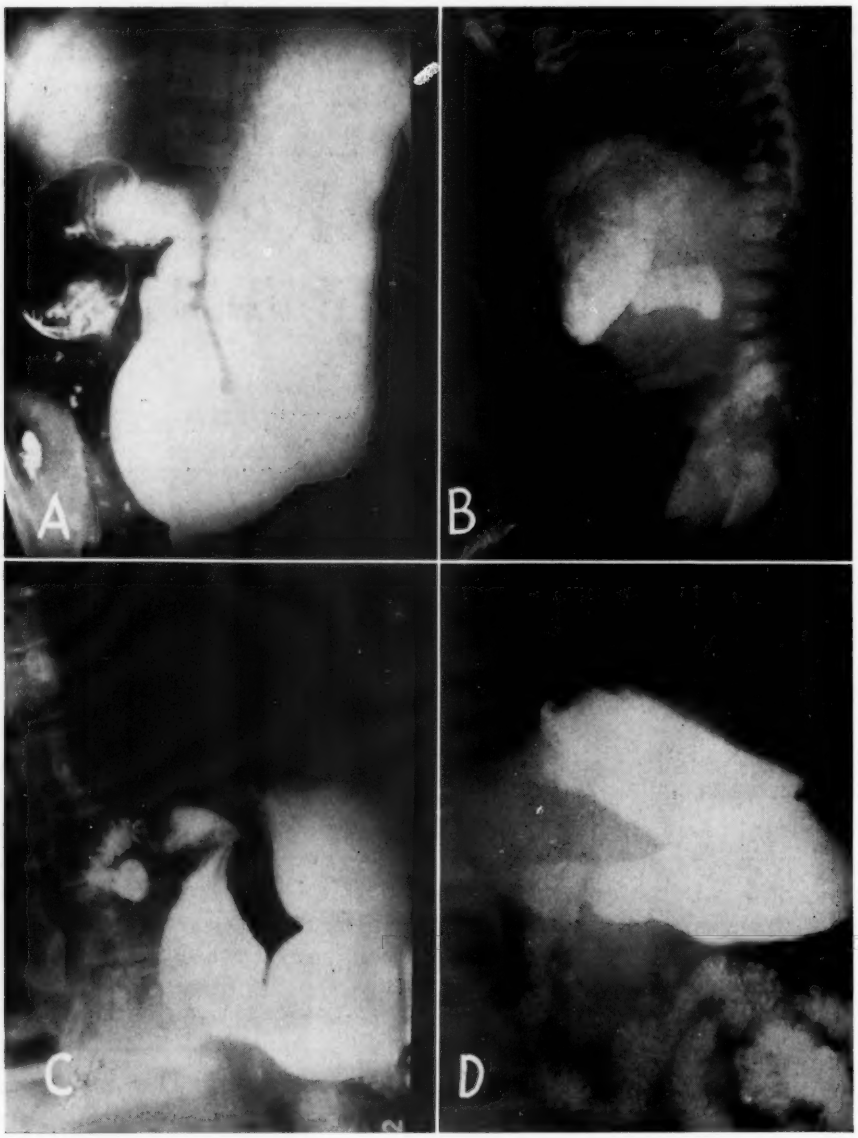

FIG. 1. Developmental and inflammatory lesions of the duodenum. (*A*) Duodenal obstruction from volvulus owing to incomplete rotation of small intestine. (*B*) Congenital duodenal stenosis proximal to the ampulla of Vater. (*C*) Diverticulum of second portion of duodenum, no symptoms. (*D*) Postbulbar duodenal ulcer showing associated spasm and niche on anterior wall just below the bulb.

the superior angle of the duodenum. Furthermore, it is reinforced by the liver above and in front, by the pancreas below, and by the kidney behind. This makes the duodenum the most fixed segment of the small intestine and it is therefore expected that an enlargement of any of the neighboring structures will be reflected in the position, shape and contour of the flexible walls of the duodenum.[7]

Diverticula of the duodenum (Fig. 1) are relatively common and probably represent the most frequent abnormality of this portion of the intestine. Larimore and Graham[21] discussed diverticula and duplication of the duodenum and felt that the majority could be classified as acquired. These may be either true or false. The true diverticula contain all layers of the intestine; the false lack the muscular layer. Weakness at the

site of entrance of vessels or ducts through the duodenal wall and inflammation are some of the factors suggested as causes of the acquired type. The majority arise from the second portion and probably produce no particular symptoms (Fig. 1*C*). Chronic cholecystitis is a common cause of pain in this area.

Of 4 cases of duodenal diverticula treated surgically,[11] 3 arose from the third portion and 1 from the second portion. One was quite large and showed abnormal retention of barium, while a second one revealed an ulcer. The other two diverticula contained a leiomyoma and leiomyosarcoma respectively. There were no typical symptoms.

Redundancy of the second portion of the duodenum was noted by Larimore and Graham[21] and others on numerous occasions. It must be differentiated from diverticula of the duodenum and from changes in normal contours due to pressure of extrinsic structures.

Intermittent obstruction and stasis[19] are among the most common disorders seen in the distal duodenum. The first evidence of duodenal stasis is a dilated duodenal cap and if the distal loops are not dilated one must think of the possibility of acute ulceration. Stasis may be due to extrinsic pressure or simply to atonicity and ptosis in asthenic individuals.

Duodenitis appears to be a definite entity which most authors find to be largely limited to the cap of the duodenum and which many feel is an antecedent lesion to duodenal ulcer. However, duodenitis does occur in the second portion and the findings in this area are quite similar to those seen when it involves the cap.

Sussman,[32] in describing this entity, mentions the abnormally increased irritability of the duodenum. This is manifested by extreme spasticity and hypermotility of the opaque medium in its passage through the duodenum. The mucosal pattern is rather coarse and irregular. An ulcer crater is not demonstrable and obstruction does not occur. At times duodenitis associated with a coincident duodenal ulcer may be present.

An extraduodenal inflammatory process may produce changes like a duodenitis. In acute pancreatitis[3,14] spasm, reverse peristalsis, areas of stasis and altered motor function occur. Edema of the pancreas may cause widening of the duodenal loop, flattening of the mucosal folds and the "reverse 3" sign.

Postbulbar duodenal ulcer[1,2] has been stated to be at least as common as gastric ulcer. The characteristic sign of postbulbar ulcer is the niche defect (Fig. 1*D*). Bleeding is three times as common as in ulcer of the duodenal cap. These lesions are often small and careful study of the second portion of the duodenum should be made in all cases of obscure upper gastrointestinal bleeding.

Congenital duodenal obstruction[18] is uncommon and there may be complete atresia or varying degrees of stenosis or diaphragm formation (Fig. 1*B*). Vomiting occurs very early in life, differentiating this lesion from pyloric stenosis. Incomplete obstruction may occur from extrinsic pressure by adhesions from the cecum in malrotation of the colon, anomalous arteries[27] and occasionally in gallbladder disease.[26]

Annular pancreas[15,24] is probably the only congenital anomaly of the gastrointestinal tract producing symptoms late in life and, although rarely suspected, may cause obstruction. This and volvulus associated with incomplete rotation of the small intestine usually obstruct in the distal part of the second portion of the duodenum (Fig. 1*A*). Enterogenous cysts[16] and multiple duplicative cysts[17] are rare but may occlude the lumen of the intestine. Kinzer[19] presented a case of intermittent duodenal obstruction due to an intraluminal diverticulum of the second portion.

Retroperitoneal rupture of the duodenum may occur with trauma to the abdominal wall. The mortality resulting from this lesion is quite high and early diagnosis is of extreme importance. Sperling and Rigler[30] report a case in which the diagnosis was made by visualization of gas in the retroperitoneal area about the right

kidney. The appearance of gas in this area is rather characteristic and is almost pathognomonic of retroperitoneal rupture of a hollow viscus.

Perforation of the second portion of the duodenum may occur during operative procedures upon the right kidney, the common bile duct or head of the pancreas. Ingested foreign bodies have been reported as becoming impacted in the duodenum although most of these lie in the first portion. Not uncommonly, one sees fistulous connections between the duodenum and biliary tract with the passage of air into the gallbladder and hepatic radicles, which is demonstrable on the plain film of the abdomen. Subsequent examination with opaque medium will usually reveal the abnormal tract. Such fistulas are in most cases associated with gallstones which have eroded through the gallbladder and duodenal walls and may produce intestinal obstruction. Demonstration of gas in the hepatic radicles may prove a valuable clue to the etiology of the obstruction in cases of non-opaque calculi.

Benign tumors of the duodenum are rare and appear as smooth, round, well demarcated filling defects. They tend to become pedunculated and then produce a mobile defect. With increase in size, obstruction and intussusception may occur. Multiple lipomas of the second portion of the duodenum[12] have been reported. Aberrant pancreatic nodules[13] of the duodenum are a common developmental anomaly and over 80 per cent are found in the second portion.

Malignant lesions of the duodenum[10] are the most frequent of all malignancies of the small intestine. Carcinoma of the second portion of the duodenum[9] occurs most frequently at or above the ampulla of Vater which is involved in over one-half of these lesions.[29] The lesion is either polypoid or stenosing, with the latter predominating, and they have the same tendency to develop in an annular or cylindrical manner as is seen in other forms of intestinal carcinoma.[22] There is distortion and destruction of the mucosal pattern with dilatation of the duodenum proximal to the lesion. Some authors[23] report little or no narrowing of the intestinal tract by the carcinoma. Varying degrees of obstruction may be seen, as well as additional complications of ulceration, bleeding and obstruction of the biliary tract if near the ampulla of Vater. This diagnosis is not usually considered because of the lack of symptoms; however, almost 30 per cent were diagnosed clinically at the Mayo Clinic in 1940.[20] The abrupt onset of symptoms with no gastric lesion and duodenal dilatation should make one suspicious of a primary malignancy of the second portion of the duodenum.

Carcinoma of the ampulla of Vater as a rule is a circumscribed polypoid or fungating lesion that occupies only a portion of the wall of the duodenum and resembles carcinoma of the head of the pancreas.[22] It produces changes and symptoms earlier than carcinoma of the duodenum and so offers a better prognosis. The combination of rapidly deepening jaundice, dark blood in the stools and roentgen evidence of a lesion in the region of the ampulla of Vater should make one suspect the possibility of a carcinoma of the ampulla. Carcinoma of the bile duct itself, while rare, is another cause of obstruction and dilatation of the duct.

Sarcoma of the duodenum[28] occurs one-tenth as frequently as does carcinoma, usually in young persons. Sarcoma encroaches on the lumen to only a small degree with no obstruction.

Weintraub and Tuggle,[34] in discussing neoplasms involving the duodenum, reviewed 20 cases, 4 of which had primary carcinoma of the duodenum, 2 were carcinomas of the ampulla of Vater. A fistulous connection between the duodenum and biliary tract was found in 1 case and the authors feel that neoplasm should be suspected when this is seen.

Enlarged lymph nodes around the duodenum may produce a central filling defect and in some cases a combination of depres-

sion and invasion of the loop may occur. Nodes and retroperitoneal tumors may also widen the duodenal loop.[23] Such changes suggest invasion by multiple destructive processes.[31] Most of the lymph node involvement in this area is metastatic in character, although primary tumors of the lymph nodes do occur and primary lymphosarcoma of the duodenal wall has been reported.[5]

Pressure defects upon the contour of the duodenum indicate a large gallbladder when the bulb is compressed. A pressure defect upon the superior angle indicates

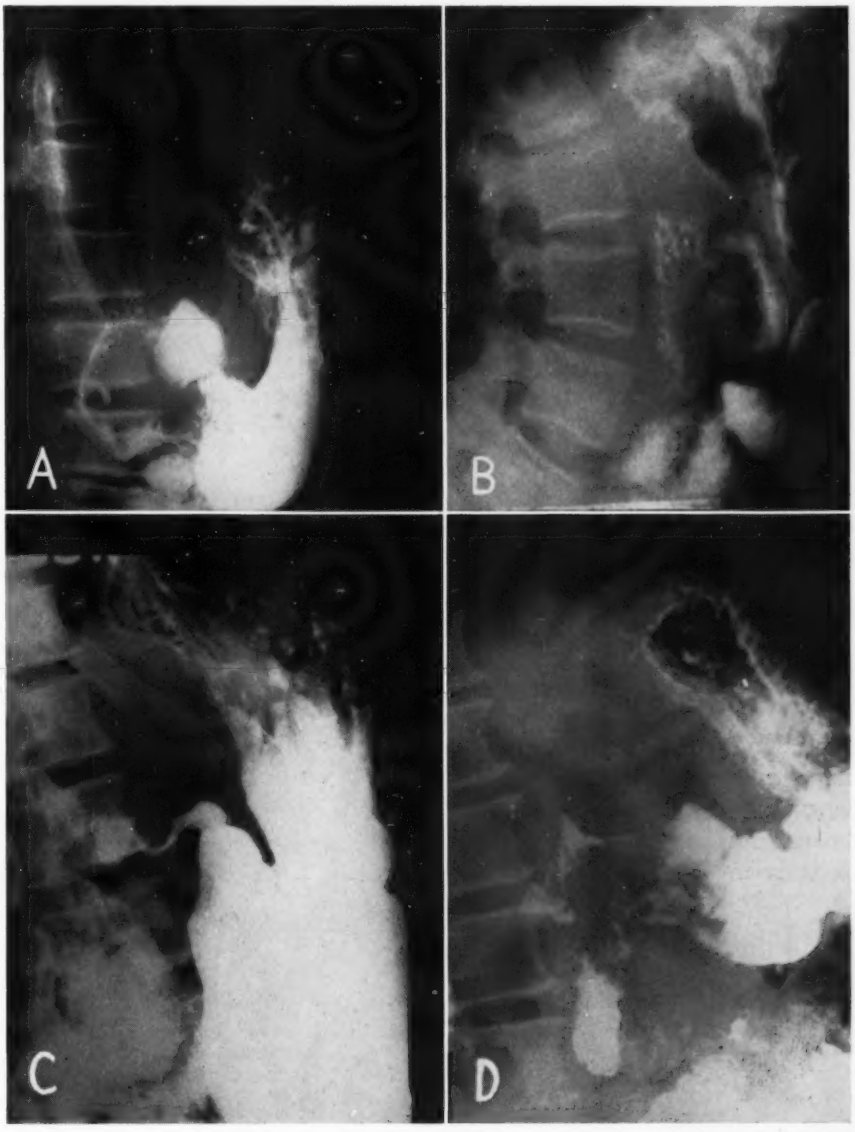

FIG. 2. Carcinoma of the head of the pancreas. (*A*) The duodenal loop is widened, the second portion compressed and the "reverse 3" sign is shown. (*B*) Widening of the duodenal loop with a large pressure defect on the greater curvature of the stomach. Patient not jaundiced; clinical impression was carcinoma of the stomach. (*C*) The pressure defect on the superior flexure of the duodenum due to dilatation of the common bile duct is demonstrated. There is a widened duodenal loop and a small pressure defect on the greater curvature of the stomach. (*D*) Marked involvement of the second portion of the duodenum and greater curvature of the stomach by an extensive malignancy. Note the "reverse 3" sign.

dilatation of the extrahepatic biliary ducts due either to stones, or, more often, to tumor. When the pressure defects are associated with jaundice, this usually indicates an obstructive type.[6,7] The cause of the obstruction is a benign lesion in 50 per cent of the cases.[3] An extrinsic pressure defect on the outer wall of the descending duodenum from an enlargement of the gallbladder or common duct with displacement of the duodenum medially in the presence of painless, increasing jaundice suggests carcinoma of the ampulla or common duct.[25] More important is the demonstration of a small filling defect or mucosal ulceration on the inner concave aspect of the second portion of the duodenum due to invasion or a tumor mass.[3]

In many cases showing dilatation of the bile ducts cancer of the head of the pancreas is the cause of the obstruction (Fig. 2). In addition to the sign of dilatation of the extrahepatic biliary tract one should look for deformity on the concave aspect of the first or second parts of the duodenal loop and the deformity is usually localized to a small segment. This was the most frequent finding in 167 cases reported by Beeler and Kirklin.[4] The typical widening of the duodenal loop was not a frequent finding in this series. Pressure defects may also be seen along any portion of the stomach, depending on location of the tumor in the pancreas[4] as well as displacement of the second portion of the duodenum posteriorly in lesions of the head of the pancreas.[8]

An exact diagnosis of carcinoma arising in the periampullary region is foolhardy, for within an area not more than 1 cm. in diameter there may originate a carcinoma of the ampulla of Vater, head of the pancreas, end of the common duct or of the duodenal mucosa.[3] Weber and Kirklin[33] have emphasized that if the existence of a lesion and its site can be predicted by the radiologist, the precise diagnosis is not necessarily required.

SUMMARY

The study of the second portion of the duodenum has proved valuable in patients with unexplained upper abdominal pain, with obscure gastrointestinal bleeding and in the differential diagnosis of lesions producing jaundice.

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DISCUSSION

DR. RICHARD SCHATZKI, Belmont, Massachusetts. I think it is important that, from time to time, we be reminded of how many different diseases can occur in that short part of the anatomy, and I believe this paper serves that purpose.

A large number of diseases were enumerated, and it is impossible to discuss them all. It is like a moving picture that passes before our eyes. We worry about whether we are missing some of these lesions during our daily work. As a matter of fact, I think we all know that we do. We are apt to miss them because we neglect this part of the gastrointestinal tract somewhat in our daily routine. Certainly we examine it very carefully if the patient has jaundice or other evidence of disease in that region, such as hemorrhage; but in the routine case, that is in the case where we should find the early lesion, we are a little apt to be satisfied with a good demonstration of the duodenal cap and take just a fleeting glance at the rest of the duodenum.

From time to time I have to remind myself forcefully that I should not be satisfied until I have seen the second and third portion of the duodenum completely. In many patients that is very easily seen, and I think it should be done in both the horizontal and vertical position. In other patients, it is more difficult getting enough barium into that part of the intestine.

A large amount of barium must be pushed through the duodenum. Due to the fact that the small intestine is so elastic, large lesions can be hidden if we fill only a part of the circumference of that particular portion. Therefore, we really have to flood that part of the anatomy with barium to be sure that there is nothing wrong.

If complete filling is difficult and a lesion is suspected clinically, I think the use of a Rehfuss tube is advisable in order to really distend that part of the duodenum.

I agree with the authors and with Kirklin and Beeler that ulceration and infiltration of the

duodenum are by far more common signs of cancer of the pancreas than is widening of the loop. As a matter of fact, widening of the loop occurs in only very large lesions which usually can be felt, and it is much more common in cysts of the pancreas.

(Slide) This slide shows a peculiarity of this part of the intestine, which might be worth while to be pointed out because it is the only place in the whole intestinal tract that shows this peculiar anatomical arrangement.

This was a child of three years of age, who for a period of five months had remittent fever and pain in the abdomen, and on whom various diagnoses had been made, until someone had the idea to take a film of the abdomen. This metallic foreign body was seen.

Examination of the gastrointestinal tract showed that this foreign body arose in the second portion of the duodenum at the junction with the third portion. At operation, the greater part of the foreign body was imbedded in the liver. The appendix was attached to it, and a chronic granuloma had formed around the needle.

It is very easy to understand why this happened. The junction of the second and third portions of the duodenum is the only part of the entire intestinal tract where both sides of the curve are retroperitoneal. All the other curves are either completely intraperitoneal or one side of the curve is intraperitoneal. Therefore, this is the only part of the curve that cannot be completely straightened out by a long foreign body, and where a person can get into trouble.

I wish to thank the authors for sending me their paper in advance and allowing me to discuss it.

Dr. Smith (closing). I would like to thank Dr. Schatzki for his remarks and for bringing in the matter of the foreign body. That was in the original paper.

I think it is of considerable interest that in practical work the second portion of the duodenum and the angle as it passes into the third portion are a much more likely site for impacted foreign bodies, and certainly the possibility of an unsuspected and undiagnosed perforation is much greater in this region.

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ROENTGEN FINDINGS IN THE "COLLAGEN" DISEASES*

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AS EVOLUTION proceeds, certain diseases become conquered or less common, other diseases develop, or become recognizable as separate entities. Some of these then acquire a nomenclature, the clarity of which is usually in direct proportion to our knowledge concerning their etiology. In one of the less clear groups would appear to fall the so-called collagen diseases. What are the collagen diseases? What are their roentgenologic aspects? What is ostensibly new concerning them? The present paper is an attempt to answer some of these questions, and to present our impressions based on review of a group of over 86 cases diagnosed as collagen disease, seen in hospital practice during the last several years.

DEFINITION

The collagen diseases are a group of disorders characterized anatomically by generalized alterations of the connective tissue, especially of its extracellular components. The following are currently accepted as members of this group:

Periarteritis nodosa
Disseminated lupus erythematosus
Dermatomyositis
Scleroderma
Rheumatic fever
Rheumatoid arthritis

The term *polyarteritis* is synonymous with periarteritis nodosa. Because of the predominance of vascular changes, this disorder (and, to a lesser extent, generalized lupus erythematosus) may also be referred to as *visceral angiitis*. Disseminated lupus erythematosus is also known as *acute lupus erythematosus* or *generalized lupus erythematosus*.

Becker,[2] and others, have suggested that the systemic manifestations of Schönlein-Henoch *purpura*, *erythema nodosum* and certain cases of *glomerulonephritis* show similar involvement of connective tissue and may belong to this group of diseases. Ehrich and associates,[4] on the basis of animal experiments, would also include *serum sickness*. Kampmeier[10] has suggested that the necrotic changes found in afferent renal arteries in both malignant hypertension and periarteritis nodosa have more than coincidental relationship. Stewart[18] believes that thromboangiitis obliterans and ulcerative colitis are also collagen diseases.

ETIOLOGY AND PATHOLOGY

The etiology of the collagen diseases is not known. Several workers have produced fibrinoid changes of connective tissue experimentally by mechanical and by chemical means.[3] These observations tend to invalidate the supposition that hypersensitivity is the sole cause of collagenous degeneration. Indeed, it has been observed that undue significance should not be attached to the occurrence of fibrinoid changes in localized connective tissue collagen. Pathologically, this is merely a form of degeneration, unspecified in etiology, and occurring in a wide variety of dissimilar diseases. This fact, of course, greatly minimizes the clinical usefulness of the term collagen disease. However, until a better term is devised and until we know more about the fundamental nature of the diseases in question, it is probably justifiable to continue the use of the term. In this connection, it is to be noted that the microscopic findings do not consist merely of changes in the collagen fibers alone, but consist of changes in the connective tissue elements as a whole.

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Histologically, connective tissue consists of cellular elements and extracellular substances. The cellular elements consist of fibrocytes and fibroblasts, macrophages, lymphoid cells, mast cells and various other leukocytes. The extracellular substances are composed of an amorphous ground substance and three known types of fibers, collagenous, reticular and elastic. The basic lesion in the collagen diseases consists of a swelling of the interfibrillary ground substance as well as swelling of the fibers themselves. The location of these basic lesions and the type of response of the adjacent tissues are somewhat different in the different collagen diseases, and constitute the anatomic basis by which they may be at least partly distinguished.

Not all clinical subdivisions of the collagen diseases are clearly demarcated. In some patients, at necropsy, lesions peculiar to or predominant in some of the different entities may be found in one and the same patient. For example, a fatal case may show:

(a) Chronic skin lesions, as in scleroderma.
(b) Atrophy of skin, and degeneration of muscle, as in dermatomyositis.
(c) Proliferation of endothelial capillary tissue, as in disseminated lupus erythematosus.
(d) Nonbacterial verrucous endocarditis.*
(e) Infiltration and dilatation of arterioles, as in periarteritis nodosa.
(f) Pericardial changes, as in rheumatic infection.
(g) Articular and tenosynovial changes, as in rheumatoid arthritis.

A case embodying all these diverse manifestations was recorded by Kampmeier.[10]

Miale[13] mentions that Krupp first emphasized a characteristic urinary finding in "visceral angiitis;" he found the pattern in 14 of 21 cases of periarteritis nodosa and disseminated lupus erythematosus. It consists of the simultaneous presence of elements usually characteristic of the early stages of nephritis (erythrocytes and erythrocytic casts), and elements usually seen in the chronic stage (broad casts, waxy casts, fatty casts, and "oval fat bodies"). This finding has been referred to as a "telescopic urinary sediment."

* Nonbacterial verrucous endocarditis, as in Libman-Sacks syndrome,[11] is now known to be part of the changes occurring in disseminated lupus erythematosus.

CLINICAL TYPES AND SOURCE OF MATERIAL

The types of collagen disease to be discussed in the following pages include periarteritis nodosa, generalized lupus erythematosus, dermatomyositis, and scleroderma. Space will permit only brief mention of the two more common entities, rheumatic fever and rheumatoid arthritis.

The cases studied were obtained by a review of the files in the roentgen departments and the record rooms at San Francisco Hospital and Stanford University Hospital. We are indebted to Dr. H. S. Kaplan for kind permission to review the films of the latter. The period covered is approximately fifteen years, a majority of the cases having been indexed in the last ten years.

PERIARTERITIS NODOSA (POLYARTERITIS)

Periarteritis nodosa is frequently and more correctly called polyarteritis as there is actually a widespread *poly-* rather than *peri*arteritis, affecting chiefly the medium-sized and smaller arteries of the body. Pathologically, there is a degeneration of the collagenous tissue in the walls of the vessels, sometimes with necrosis of the media, rupture of the elastic lamina and infiltration of inflammatory cells and eosinophils into all of the vascular layers. When this infiltration of the arterial coats is localized, or is followed by local fibrosis, or the development of small aneurysmal dilatations, nodular changes develop (giving rise to the term nodosa).

Clinically, the signs and symptoms are determined more by the distribution of the involved arteries than by the disease process itself. Almost any clinical condition

may be mimicked. However, a polysystemic involvement with chronic fever, leukocytosis, eosinophilia and secondary anemia suggests the condition, and is an indication for skin and muscle biopsy.

Roentgenologically, findings may or may not be present, depending on which systems happen to be involved, and also on the acuteness and degree of that involvement. Cardiac enlargement and/or pericardial effusion occurs. The respiratory system may show massive symmetrical or nonsymmetrical edema in severe acute cases. In others, small hazy shadows or nonconfluent patches of edema (pulmonary hives) may be scattered throughout the lung fields, usually peripherally and at the bases.[1] Some authors[5,16] report cases in which the nodulation is most marked centrally. In addition to the nodular densities, the pulmonary linear markings may be accentuated, particularly the hilar and basal ones. Pleural effusion, secondary to pneumonitis or pulmonary infarction, is reportedly not uncommon.

Roentgen examination of the abdomen is frequently requested since abdominal pain is one of the commonest early symptoms. A triad of myositis, abdominal pain and weight loss has been referred to by some. The abdominal films usually show either no abnormality, or some gas collections suggesting paralytic obstruction (so-called adynamic ileus). Very rarely, there may be a perforated ulcer, intestinal infarction or pancreatic necrosis. One of our cases had both intraperitoneal and retroperitoneal bleeding due to ruptured aneurysm of a small mesenteric vessel, secondary to "healed" arteritis. A hypertension of 200/140 was present; this patient also had multiple duodenal ulcers.

Renal lesions are the commonest of all the systemic lesions, being present in 80 per cent of the cases.[12] Occasionally hypertension or hematuria may be so prominent that intravenous urograms are requested. These usually show either normal or decreased function.

The records of 29 cases of periarteritis nodosa were reviewed. In 28 of these, *chest films* were available and disclosed the findings shown in Table 1. It is to be noted that some cases had more than one finding (*e.g.*, pericardial, pleural and pulmonary lesions).

TABLE I

CHEST ROENTGEN FINDINGS IN 28 CASES OF PERIARTERITIS

No evidence of disease		9
Evidence of disease		19
Cardiac enlargement	4	
Pericardial effusion	4	
Pleural effusion	4	
Pulmonary changes	14	
(Parenchymal nodules, patches, etc.		4
Pulmonary congestion, passive		6
Accentuated markings, ? arteritis		3
Pulmonary edema, massive		1

Note: Some of the cases with "cardiac" enlargement may also have had some pericardial effusion.

One of our cases had at autopsy both polyarteritis and rheumatic heart disease (mitral and aortic stenosis with insufficiency). His roentgenograms showed an enlarged heart, pulmonary congestion and pleural effusion.

None of the above roentgen findings are diagnostic per se of periarteritis nodosa, but the presence of pulmonary, pleural or cardiopericardial changes in a patient with involvement of other systems, should cause one to bear the possibility of a collagen disease in mind.

In the entire 29 cases, adequate roentgenological records of systems other than the cardiorespiratory were limited. In 2 cases, hepatomegaly and in 2 cases splenomegaly were noted by our department. One case showed roentgen evidence in mild paraltyic ileus. Three cases showed peptic ulcer (1 gastric and 2 duodenal). No cases of gross renal enlargement were recorded, but 1 did show poor function by excretory urography. No bone changes were noted; 3 patients showed roentgen evidence of articular disease (2 synovial thickening, 1 rheumatoid arthritis). Biospy or necropsy material compatible with the diagnosis of periarteritis nodosa was available in 17 out of the 29 cases. In 7 cases biopsy reports

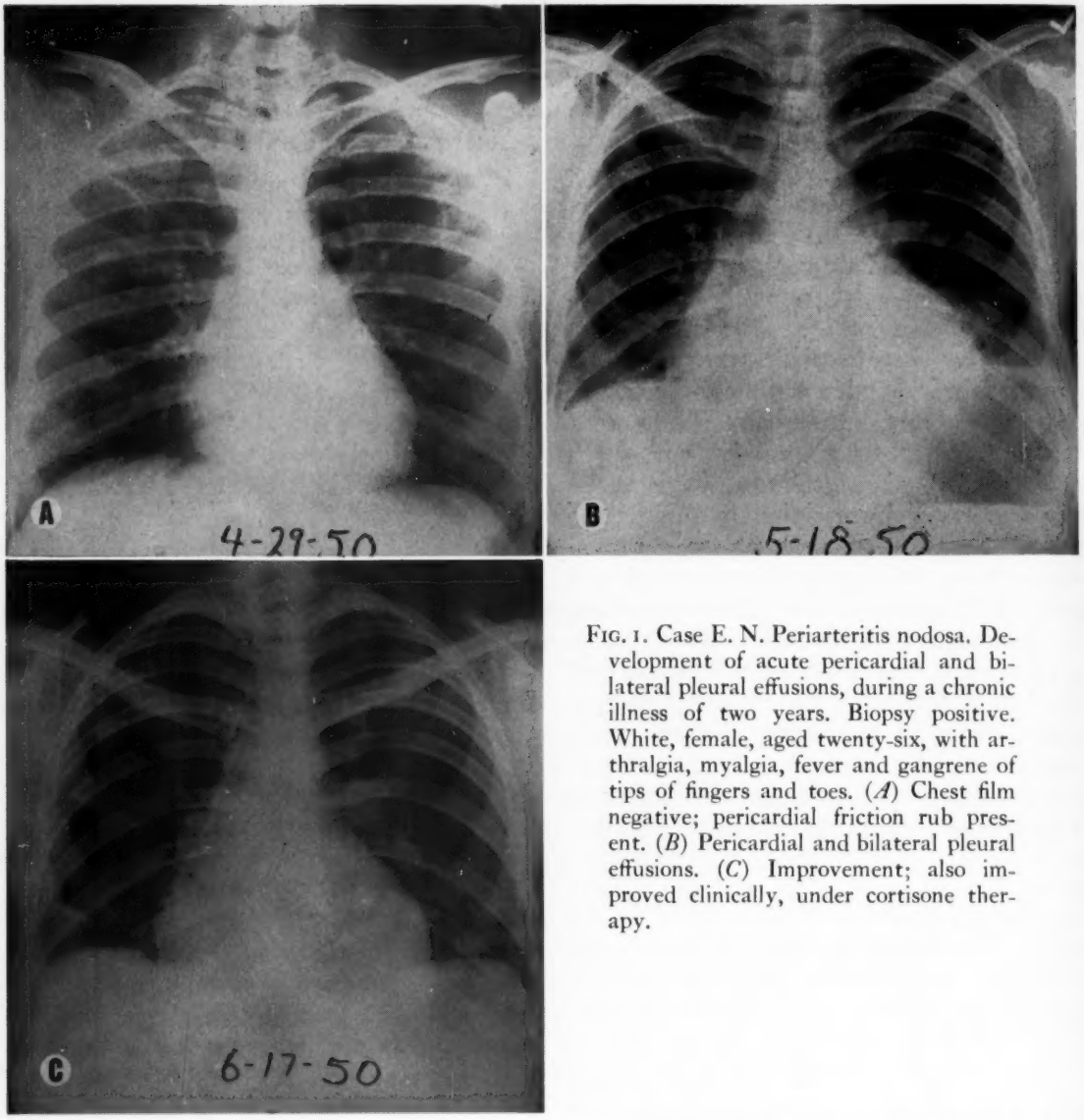

Fig. 1. Case E. N. Periarteritis nodosa. Development of acute pericardial and bilateral pleural effusions, during a chronic illness of two years. Biopsy positive. White, female, aged twenty-six, with arthralgia, myalgia, fever and gangrene of tips of fingers and toes. (*A*) Chest film negative; pericardial friction rub present. (*B*) Pericardial and bilateral pleural effusions. (*C*) Improvement; also improved clinically, under cortisone therapy.

were negative, but the clinical evidence was outstanding; 2 of these patients died apparently of the disease.*

The following are some illustrative cases:

Case E. N., a white female, aged twenty-six, with migratory joint pains, low grade fever, myalgia and patchy gangrene of some of the fingers and toes. She was known to have had periarteritis nodosa for two years. On April 29, 1950, a roentgenographic examination of the chest was negative. Re-examination in 2½ weeks showed small bilateral pleural effusions and a pericardial effusion. One month later, after cortisone therapy, clinical and roentgenographic improvement was present. This case showed acute development of pleural and pericardial lesions during the course of a chronic multiple system disease. Biopsy of skin and muscle positive for periarteritis nodosa.

Case R. S., male, aged sixty-three, with fainting spells of unknown origin for a few weeks, and pain and stiffness of the shoulders and knees since a fall one month prior to entry.

* Most of the histopathological studies referred to in connection with the cases reported in this paper were made by members of the Stanford University Medical School Department of Pathology staff; in a few instances material was reported by the University of California staff at the San Francisco Hospital, to whom we are indebted.

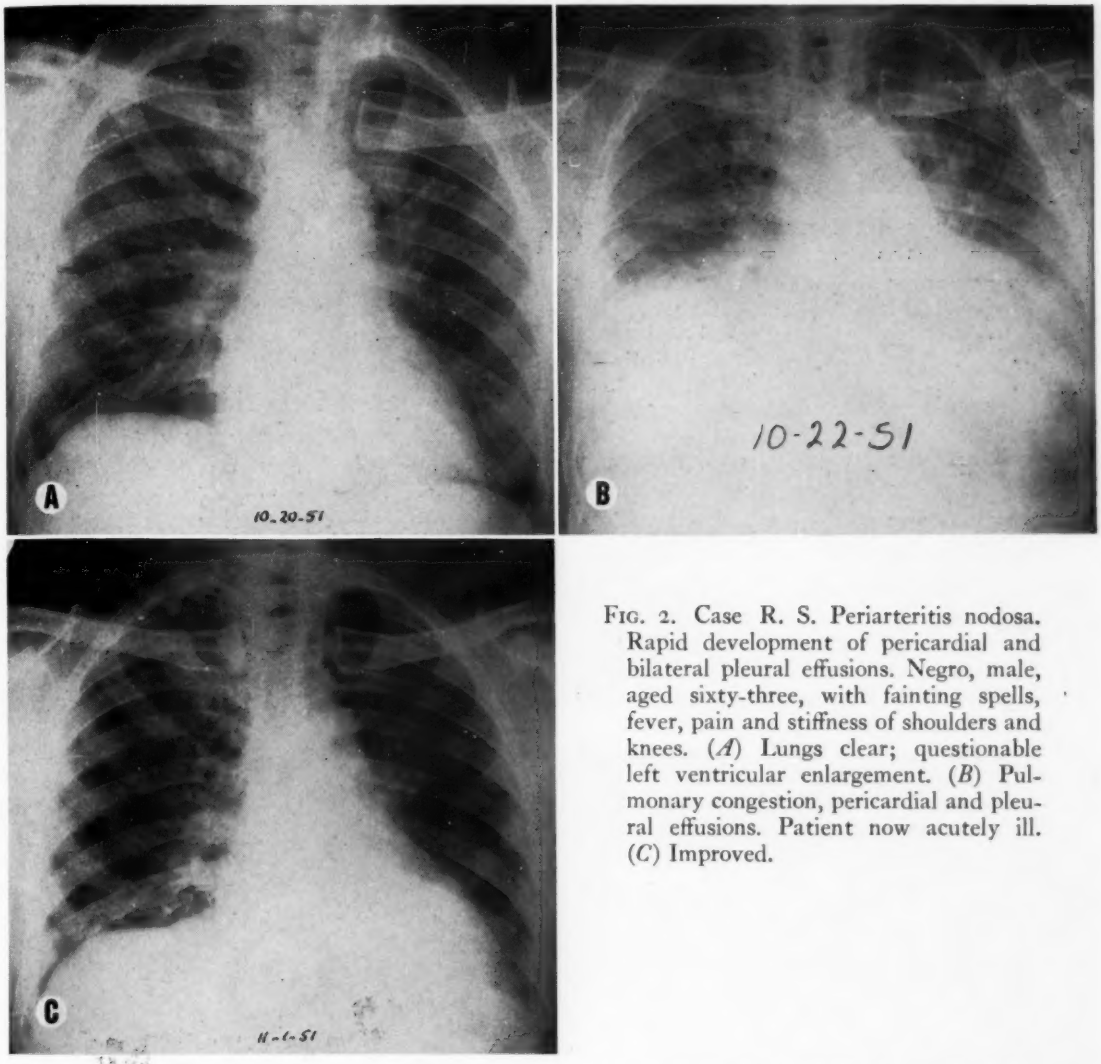

FIG. 2. Case R. S. Periarteritis nodosa. Rapid development of pericardial and bilateral pleural effusions. Negro, male, aged sixty-three, with fainting spells, fever, pain and stiffness of shoulders and knees. (*A*) Lungs clear; questionable left ventricular enlargement. (*B*) Pulmonary congestion, pericardial and pleural effusions. Patient now acutely ill. (*C*) Improved.

Initial chest roentgenograms showed only slight left ventricular enlargement. Two days later, films showed bilateral pleural effusion and pulmonary congestion. Clinically he had become acutely ill, with high fever (up to 103.1° F.), but without evidence of cardiac failure. Roentgen examination four weeks later showed clearing of the congestion and effusions, despite the fact that the patient was failing generally. The urine then showed abnormal findings, the so-called telescopic sediment, and the possibility of "visceral angiitis" became entertained. He recovered partially and was discharged. Biopsy of skin and muscle was reported negative.

CASE L. E. L., a white female, aged thirty-four, with asthma for one year, numbness of the left leg and pain in the left foot for six months. She was found to have splenomegaly, eosinophilia and a renal lesion, with casts and cells. Chest films showed pulmonary nodulation, fibrosis and emphysema. Biopsy of skin and muscle, negative. Marked clinical and roentgenological improvement occurred within three days after cortisone was started. She was discharged improved.

CASE R. C., a white longshoreman aged forty-five, entered on August 12, 1948, with chilliness, fever (101° F.), mild cough, chest pain and dyspnea. He had had a dermatitis of his leg for two years, with local ulceration. He developed right upper quadrant pain, a markedly enlarged liver and massive hematuria. He had a hypertension of 180/80; his blood urea was

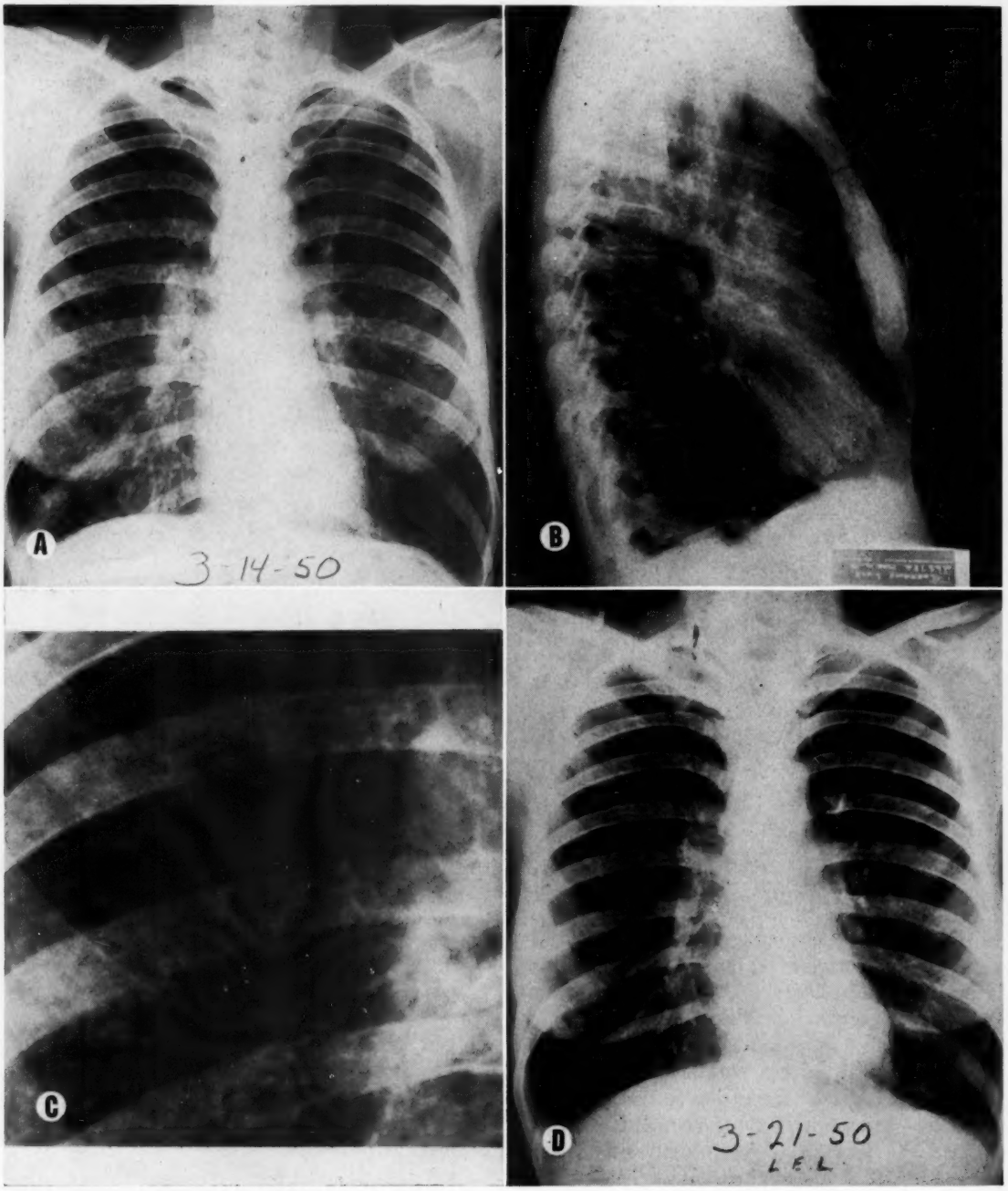

Fig. 3. Case L. E. L. Periarteritis nodosa. Pulmonary nodulation and improvement under cortisone therapy. White, female, aged thirty-four. Asthma for one year; then leg pains, eosinophilia. Splenomegaly; renal lesion with casts and cells. (*A*) Pulmonary nodulation and possible emphysema. (*B*) Lateral view. (*C*) Closeup of right mid-lung field. (*D*) Marked improvement on fourth day of cortisone therapy.

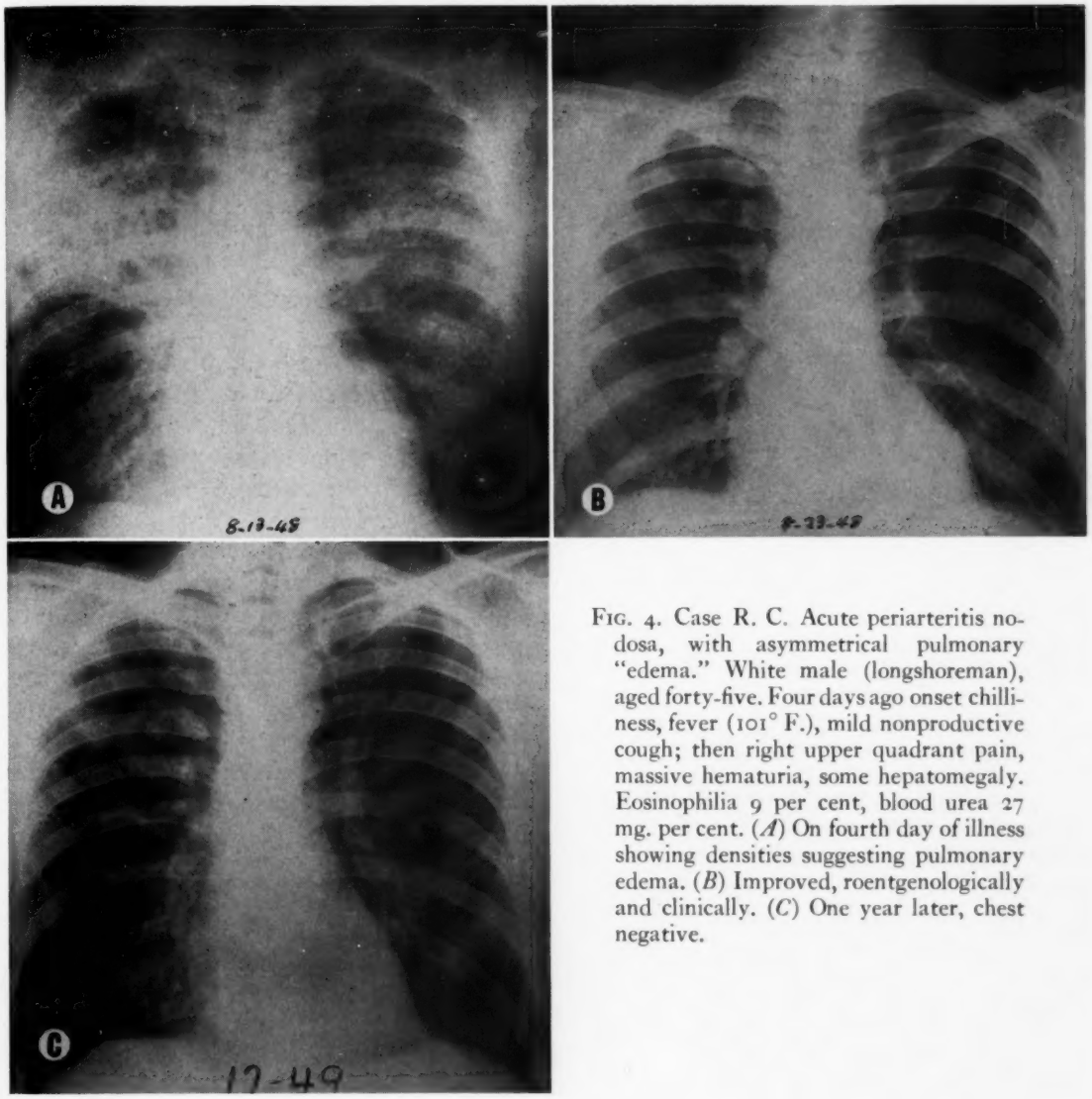

FIG. 4. Case R. C. Acute periarteritis nodosa, with asymmetrical pulmonary "edema." White male (longshoreman), aged forty-five. Four days ago onset chilliness, fever (101° F.), mild nonproductive cough; then right upper quadrant pain, massive hematuria, some hepatomegaly. Eosinophilia 9 per cent, blood urea 27 mg. per cent. (*A*) On fourth day of illness showing densities suggesting pulmonary edema. (*B*) Improved, roentgenologically and clinically. (*C*) One year later, chest negative.

27 mg. per cent; the white blood cell count was normal. Roentgenograms showed clouding of the right upper lobe and of the left mid-lung field, interpreted as pulmonary edema; moderate splenomegaly was noted on an abdominal film. Nine days after entry he was clinically and roentgenologically improved. Biopsy not performed. A year later, his chest film continued to be negative.

CASE G. H. B., a white male, aged forty, has been clinically diagnosed as rheumatoid arthritis. Roentgenograms showed a cardiomegaly, predominantly left ventricular, and a bilateral pleural effusion. He died shortly after examination, apparently from cardiac failure. Autopsy showed:

1. Diffuse collagen disease with
   a. Polyserositis (peritoneal, pleural and pericardial fluid)
   b. Rheumatic heart disease (aortic valve stenosis)
   c. "Wire-looping" of renal glomeruli (as in lupus erythematosus)
   d. Rheumatoid arthritis
   e. Periarteritis nodosa (of pulmonary, thyroid and testicular arteries)
2. Pulmonary emphysema (and fibrosis)
3. Generalized arteriosclerosis (coronary, aortic and renal).

This case illustrated a combination of four types of "collagen" disease—periarteritis nodosa, lupus erythematosus, rheumatoid arthritis and rheumatic carditis.

DISSEMINATED LUPUS ERYTHEMATOSUS

Disseminated lupus erythematosus, or systemic lupus erythematosus, is a disease most commonly seen in women, and in the ages of twenty to forty. It is characterized by a cutaneous eruption, most often in the form of discoid lesions—with a butterfly distribution over the nose and cheeks—along with varying degrees of visceral manifestation, notably in kidneys, heart, spleen and lungs. The skin lesion is frequently photosensitive, being made worse by sunlight or ultraviolet light or such light-sensitizing drugs as the sulfonamides. Patients may show fatigue, arthralgia and fever. The laboratory findings include leukopenia, and elevated sedimentaion rate, a "telescopic" urinary sediment and the presence of so-called lupus erythematosus cells[9]. These lupus erythematosus cells, found only in this disease, are seen in various preparations of blood and bone marrow and are reportedly large leukocytes containing phagocytosed material resulting from lysis of the nuclei of other leukocytes.

Pathologically, there is predominant involvement of the smaller arteries and arterioles. Polyserositis is common, with pericardial lesions the most frequent. In the heart itself, lesions predominate in the valvular structures and the mural endocardium. The kidneys, when involved, tend to be enlarged. The glomerular vessels show the so-called "wire-loop" appearance due to eosinophilic thickening of the vascular loops within the glomeruli. Occasionally, the renal changes resemble those of glomerulonephritis or periarteritis nodosa. The spleen shows microscopic involvement in at least half of the cases (periarterial fibrosis). The lymph nodes are said also to be frequently involved, showing "free hematoxylin-staining bodies."*

* Klemperer, P., *et al.* Cytochemical changes of acute lupus erythematosus. *Arch. Path.*, 1950, *49*, 503–516.

Roentgenologically, findings may be noted in the urinary and respiratory tracts. In the urinary tract, when a case of hypertension shows unusually large kidneys, the possibility of disseminated lupus erythematosus rather than a chronic glomerular nephritis must be considered. Patients with the latter condition tend to have small or contracted kidneys.

Pulmonary involvement is remarkable for its frequency and its atypical course. Rakov and Taylor[15] and Foldes[6] describe a chronic interstitial pneumonitis which leads to atelectasis (due to interstitial edema and inflammation resulting in obliteration of some alveoli)—termed atelectasizing pneumonitis. These lesions are regarded as different from the ordinary pyogenic and fibrinous types of bronchopneumonia which so frequently complicate the terminal stages of lupus erythematosus.

Thorell[19] reviewed the roentgenograms of 15 cases of disseminated lupus erythematosus and found 8 with pleural or pulmonary parenchymal changes, or both. The pleural effusions were generally small; the pleural thickening more or less irregular. These pleural changes varied in extent in relatively short periods of time. The parenchymal changes consisted of small areas or patches of increased density, mostly subpleural, especially in early and moderately advanced cases. (He used different oblique projections to bring out the subpleural location of the lesions.) He believed that a combination of pleural and subpleural change ought to lead to the correct diagnosis even if the changes in themselves were not characteristic!

In our experience, pleural and pericardial effusions were the commonest findings in this group. The pulmonary parenchymal changes varied from localized accentuated markings, nodules and patches, to extensive edema.

We have reviewed the records of 35 cases, in 32 of which chest films were available (see Table II).

In these cases, the pulmonary changes consisted of accentuated basal bronchovas-

Table II

CHEST ROENTGEN FINDINGS IN 32 CASES OF DISSEMINATED LUPUS ERYTHEMATOSUS

No evidence of disease		11
Evidence of disease		21
Cardiac enlargement	5	
Pericardial effusion	5	
Pleural effusion	13	
Pulmonary changes (Accentuated markings, nodules, densities or edema)	10	

cular markings in 2 instances, of nodular or patchy pulmonary densities (edema?) in 6 instances, and of diffuse pulmonary density (edema) in 2 instances.

As far as other anatomic sites are concerned, our roentgenological findings are limited. In 1 case hepatomegaly was reported; in 2 cases, ascites was noted. No gastrointestinal lesions were detected. In 1 case, slight osteoporosis of the hands was noted. While many of our cases had clinical evidence of joint disorder, none were so reported roentgenologically (largely because examination was not regarded as necessary by the ward physician).

Biopsy or necropsy material compatible with the diagnosis of disseminated lupus erythematosus was available in 24 out of the 35 cases. In 2 cases biopsy reports were negative.

The following are illustrative case reports:

Case F. N., aged nineteen, white, had a facial rash of butterfly shape, fever, joint pains for six months and generalized edema (nephrotic syndrome?) for four weeks. Chest films showed a small amount of fluid in the costophrenic sulci. This minimal bilateral effusion, without other roentgen evidence of chest disease, is one of the more suggestive findings of disseminated lupus erythematosus—in patients with concomitant clinical findings. Biopsy was not performed.

Case T. S., a school boy, aged thirteen, entered with high fever and weakness, a splenomegaly and lymphadenopathy of two months' duration and a butterfly facial rash for a month. The initial chest film showed slightly accentuated pulmonary markings. Three days later bedside films showed a bilateral pneumonitis, and six days later the patient died. Autopsy showed a disseminated lupus erythematosus and also a bilateral atypical lobar pneumonia with features suggesting the anaphylactic pneumonia of Rich.[17] This is a type reported by

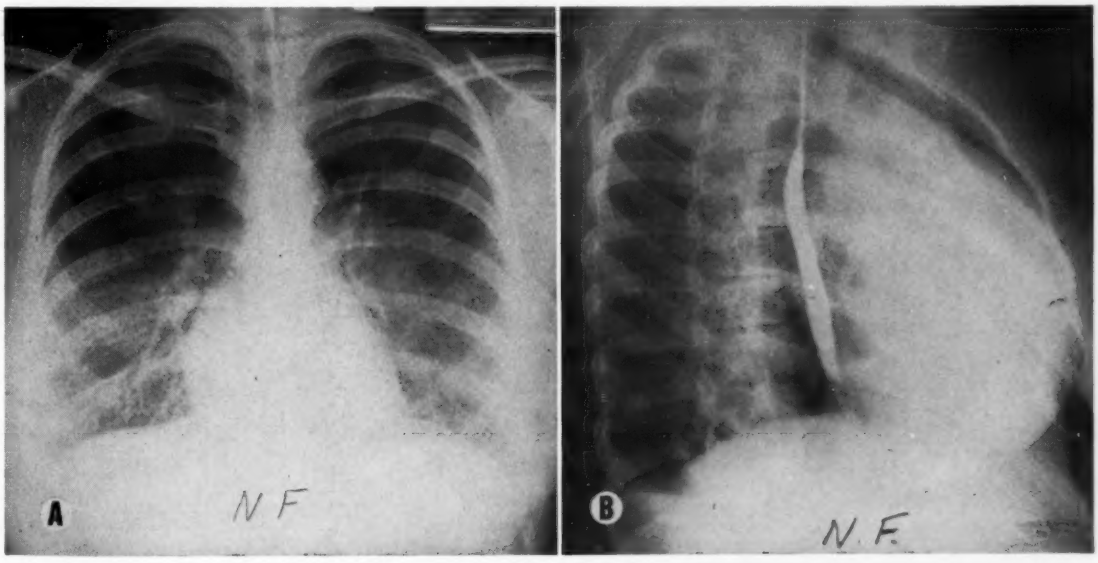

Fig. 5. Case N. F. Disseminated lupus erythematosus, with small bilateral pleural effusions. White, female, aged nineteen. A facial rash, fever, and joint pains for six months. "Nephrotic syndrome" for four weeks. (*A*) Bilateral pleural effusions. (*B*) Right oblique view; fluid seen posteriorly. Similar findings were present in left oblique view.

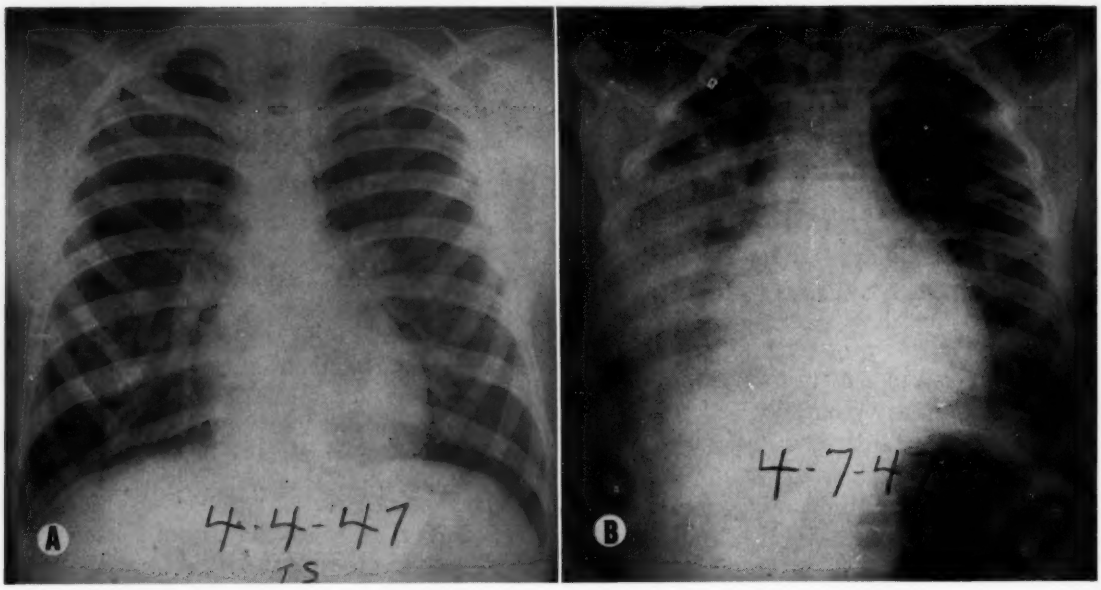

Fig. 6. Case T. S. Disseminated lupus erythematosus, with development of atypical pneumonia or pneumonitis. White, male, aged thirteen. Fever, weakness, splenomegaly and lymphadenopathy for two months. Butterfly facial rash one month. (*A*) Slightly accentuated pulmonary markings. (*B*) (Bedside film). Consolidation on right (? pneumonia); patchy basal densities on left (? pneumonitis). Patient died six days later. Autopsy showed disseminated lupus erythematosus and bilateral atypical lobar pneumonia, with features suggesting anaphylactic pneumonia.

Rich as occurring in rheumatic fever and sulfonamide sensitivity.

Case C. G., housewife, aged twenty-five, had peripheral arthritis, with migratory joint pains, an episode of hematuria one month ago, and fever and a pericardial friction rub for three days. Roentgenograms showed some small nodular densities in the right lower lung field, small bilateral pleural effusions, and an enlarged heart. An intravenous urogram was negative. Biopsy was not performed.

These polysystemic manifestations (articular, renal, pericardial, pulmonary), plus the small

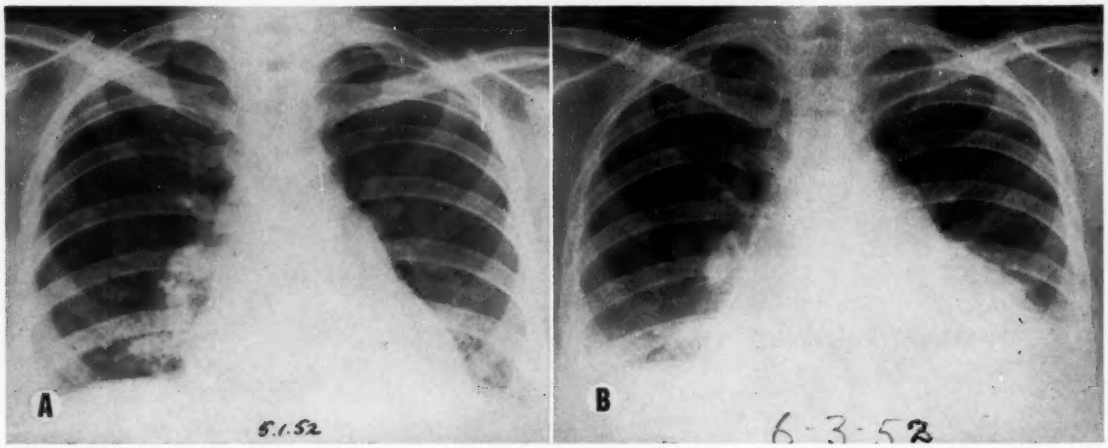

Fig. 7. Case C. G. Disseminated lupus erythematosus, showing right basal nodular densities, with pleural and pericardial effusions. White, female, aged twenty-five. Peripheral arthritis, hematuria, fever and pericardial friction rub, three days. (*A*) Small nodular densities, right base, small bilateral pleural effusions, enlarged heart vessel shadow. (*B*) Right basal nodulations obscured or not present; effusions increased. Discharged unimproved.

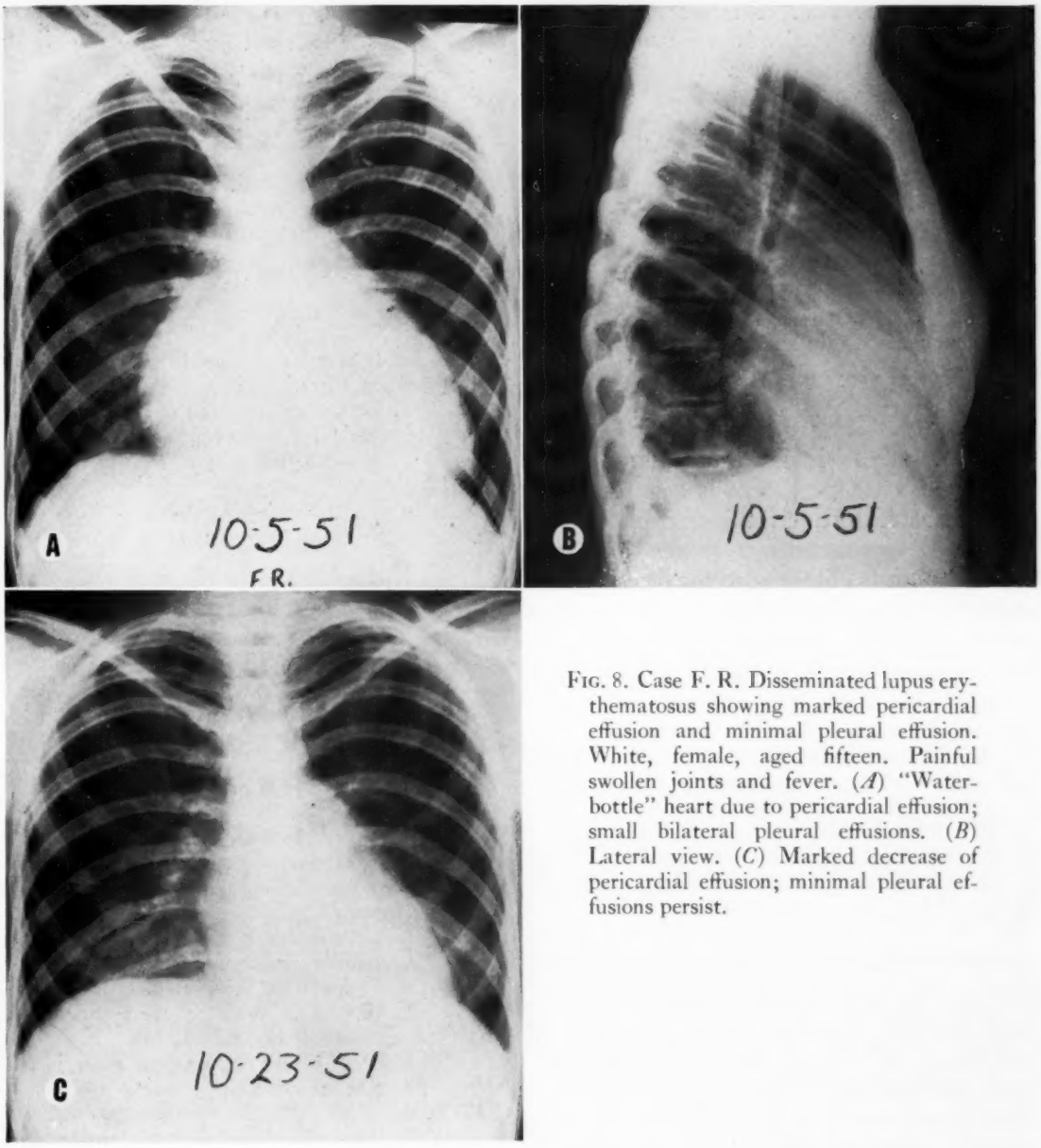

Fig. 8. Case F. R. Disseminated lupus erythematosus showing marked pericardial effusion and minimal pleural effusion. White, female, aged fifteen. Painful swollen joints and fever. (*A*) "Water-bottle" heart due to pericardial effusion; small bilateral pleural effusions. (*B*) Lateral view. (*C*) Marked decrease of pericardial effusion; minimal pleural effusions persist.

bilateral pleural effusions, are highly suggestive of a collagen disease. This patient represents one of the small number of cases of disseminated lupus erythematosus who develop no skin lesions during their illness. Other cases may show the skin lesions only fleetingly.

Case F. R., a school girl, aged fifteen, developed painful, swollen joints and fever. Chest roentgenograms showed a "water-bottle" shaped heart suggesting pericardial effusion (this was confirmed by roentgenoscopy); she also had minimal bilateral pleural effusions. Examination eighteen days later showed a marked decrease in heart size; the pleural effusions were unchanged. The clinical diagnosis was disseminated lupus erythematosus. No biopsy was performed.

Case R. P. W., white male, aged thirty-six, with a history of chorea at the age of twelve, developed a butterfly rash 2½ years ago, then hematuria and fever, weakness and fatigue. Ten months ago he was hospitalized and a diagnosis

of disseminated lupus erythematosus and aortic insufficiency was made. The blood pressure was 170/96. Recently he developed marked orthopnea and minimal edema. The blood pressure varied from 160/90 to 200/110. Roentgenograms, ten days before death, showed cardiac enlargement. He died in cardiac failure. Autopsy showed a chronic glomerular nephritis (without evidence of disseminated lupus erythematosus) and spleen lesions consistent with disseminated lupus erythematosus. There was microscopic evidence of active rheumatic lesions. This case again showed a combination of "collagen" diseases.

DERMATOMYOSITIS

Dermatomyositis is the rarest of the collagen disease group and is characterized by a nonsuppurative inflammation of the skin, the subcutaneous tissues and the skeletal muscle. There also may be inflammatory changes in the vessels, the myocardium and the muscles of deglutition. Little is known about the roentgenological features. We have had only one autopsy proved case, this showing a cloudy swelling of the myocardium and a congestive failure. Chest roentgenograms taken a year before death showed a heart slightly larger than normal, but several weeks before death the heart vessel shadow was normal in size. The lungs were clear.

SCLERODERMA

Scleroderma is a polysystemic disease, with fairly well known roentgen findings (see Table III). Large series of cases have been reported in the literature, one of the most comprehensive, from the roentgenological viewpoint, being that by Pugh.[14] Based on this material, plus our own experience, we believe that Table III summarizes the more important roentgenological changes in this disease.

We have reviewed 10 microscopically proved cases of scleroderma in our hospital, 5 of which showed some degree of small intestinal abnormality. In 1 case, the first suggestion of scleroderma was made by one of us upon examining a film of the small intestine. We have the impression that the small intestinal involvement often starts as a dilatation of the third portion of the duodenum, and then progresses distally. One case, however, appeared to start with areas of narrowing. The mortality in our particular group of patients with small intestinal scleroderma was high (3 out of 5).

One of the 10 cases showed pulmonary disease.

Table III

Summary of the roentgenological findings in scleroderma

- A. Gastrointestinal Tract
  - (1) Esophagus
    - a. Loss of peristalsis due to rigidity
    - b. Variable degrees of dilatation
    - c. Occasional narrowing of distal esophagus
    - d. Occasional shortening of esophagus
  - (2) Stomach
    - a. Peristalsis may be decreased
    - b. Hiatus hernia may develop
  - (3) Small Intestine
    - a. Peristalsis decreased or absent
    - b. Widening, especially of duodenum and jejunum; this may be segmental
  - (4) Colon
    - a. Peristalsis decreased
    - b. Segmental narrowing
- B. Lungs
  - (1) Diffuse or localized fibrosis
  - (2) Diffuse or localized nodulation
  - (3) Subpleural "cystic disease" (basal)
  - (4) Calcification (calcinosis)
- C. Heart
  - (1) Decreased amplitude or excursion
  - (2) Heart may be small, normal or large
- D. Phalanges
  - (1) Absorption of distal phalanges in advanced cases
  - (2) Occasional increase density of phalanges
  - (3) Occasional synostosis, distal and middle phalanges
- E. Soft Tissues
  - (1) Calcinosis—fairly frequent and often accompanies phalangeal absorption
    - a. Varies from "sand" to plaques
    - b. Usually in pressure areas: fingertips, elbows, ischial tuberosities
    - c. Usually seen only where there is cutaneous sclerosis
- F. Teeth
  - (1) Uniform widening of the periodontal spaces (reported in 7% of cases)

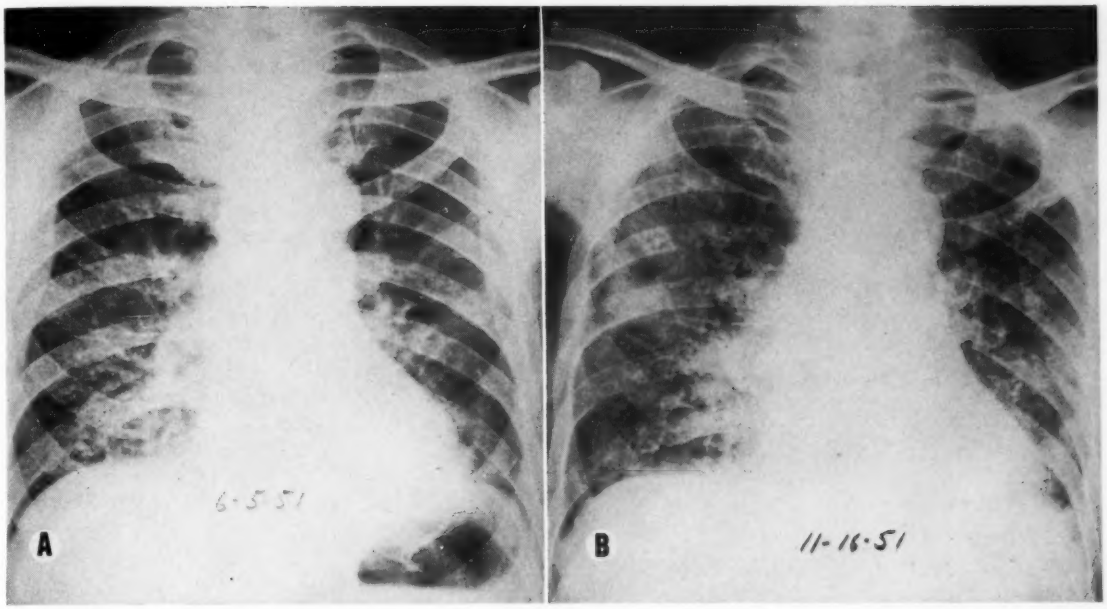

Fig. 9. Case R. L. P. Scleroderma, with pulmonary involvement. Chinese, male, aged seventy-five. Weight loss, weakness, dyspnea, ankle edema, productive cough. Scleroderma of skin. Autopsy proved. (*A*) Slight cardiac enlargement and slight prominence of the pulmonary markings. (*B*) Bilateral linear and nodular densities; patchy density, right upper lobe; small left pleural effusion. Three days later started corticotropin Died on eighth day of medication of ruptured diverticulum (diverticulitis) of the colon.

Case R. L. P., a Chinese male, aged seventy-five, had weight loss (from 150 down to 116 pounds), marked weakness, dyspnea, ankle edema, and a cough productive of white, frothy phlegm. The skin of the face and fingers appeared drawn, tense and shiny. He died of a ruptured diverticulum (diverticulitis) of the mid-ascending colon eight days after starting on corticotropin. Chest roentgenograms five months before death showed minimal prominence of the lower lobe pulmonary markings and slight cardiac enlargement. Examination three days before starting corticotropin showed hazy widening of the pulmonary markings throughout both lung fields, with a few areas of small (2 to 3 mm.) hazy nodules along the course of these markings. The changes were more evident in the right upper lobe, where one patchy density (1.5 by 3 cm.) was also present. The left costophrenic sulcus was blunted by fluid.

Among several clinically diagnosed cases of scleroderma, we have seen one with subpleural cystic changes. Case D. R., a female Negro, aged thirty, with definite scleroderma for twelve years. Chest roentgenograms showed a peculiar "spongy" appearance in the bases, presumably due to cystic changes, as described by Getzowa[7] in 2 cases. These were cases interpreted as examples of "cystic and compact pulmonary sclerosis," The "cysts" varied from pinhead size up to 1.5 cm. in diameter. Only one showed concomitant extensive fibrosis. The cystlike changes were believed to be due to a disappearance of alveolar tissue in the lung secondary to lysis of the alveolar walls and progressive sclerosis. This sclerosis is reportedly on a basis of a "hyaline process involving the alveolar walls, accompanied by the disappearance of capillaries, superimposed on a generalized, diffuse simple fibrosis of the alveolar walls."

Case M. K., a white female, aged forty-two, was admitted with a history of attacks of abdominal pain, nausea, vomiting and diarrhea for about eighteen months. She had had peripheral vascular changes of the Raynaud's disease type for two years. About eleven months before entry she had had a cholecystectomy; chronic cholecystitis was reported. Roentgen

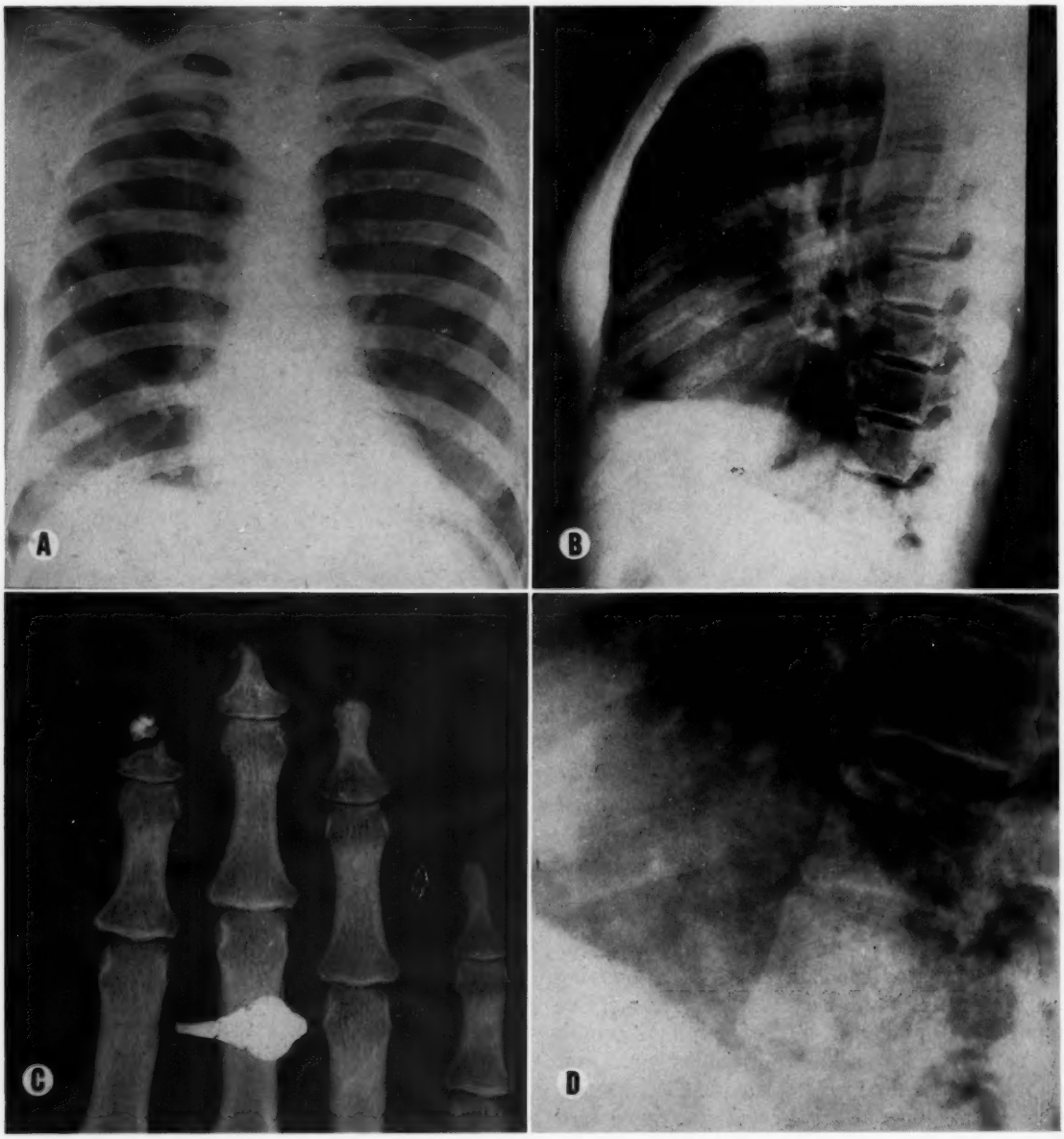

Fig. 10. Case D. R. Scleroderma, with cystic disease of the lung bases. Female, Negro, aged thirty. Scleroderma for twelve years. (*A*) Mottled radiolucencies (? cysts) in lung bases. (*B*) Lateral view. (*C*) Tuft absorption and calcinosis. (*D*) Detail view of cystic appearance.

examination revealed widening and delay in the third portion of the duodenum and proximal small intestine. Roentgenoscopically, the esophagus showed sluggish passage of the barium. Roentgenograms of the chest and hands were negative. Six months later she died "from asthenia," and autopsy examination showed generalized scleroderma.

Case C. L., a white female, aged thirty-six, had sclerodermal symptoms for three years, starting as pain and stiffness in the extremities, followed by Raynaud's phenomena. About one month before entry nausea, anorexia and dysphagia occurred. Roentgen examination showed esophageal involvement, with widening, decreased peristalsis and marked delay in emptying. A skin biopsy showed changes interpreted as scleroderma. She was seen 2½ years later, showing only slow progression of the disease.

Fig. 11. Case M. K. Scleroderma, with small intestinal involvement. White, female, aged forty-two. Raynaud's phenomenon two years. Attacks of abdominal pain, nausea, vomiting, diarrhea, 1½ years. Autopsy, six months after examination, showed generalized scleroderma. Roentgenograms showed upper small intestinal dilatation and delay.

Fig. 12. Case C. L. Scleroderma, with esophageal involvement. White, female, aged thirty-six. Disease onset three years ago. Recent nausea, anorexia and dysphagia. Biopsy of skin showed scleroderma. (*A*) (*B*) Roentgen examination: esophageal widening, decreased peristalsis and marked delay.

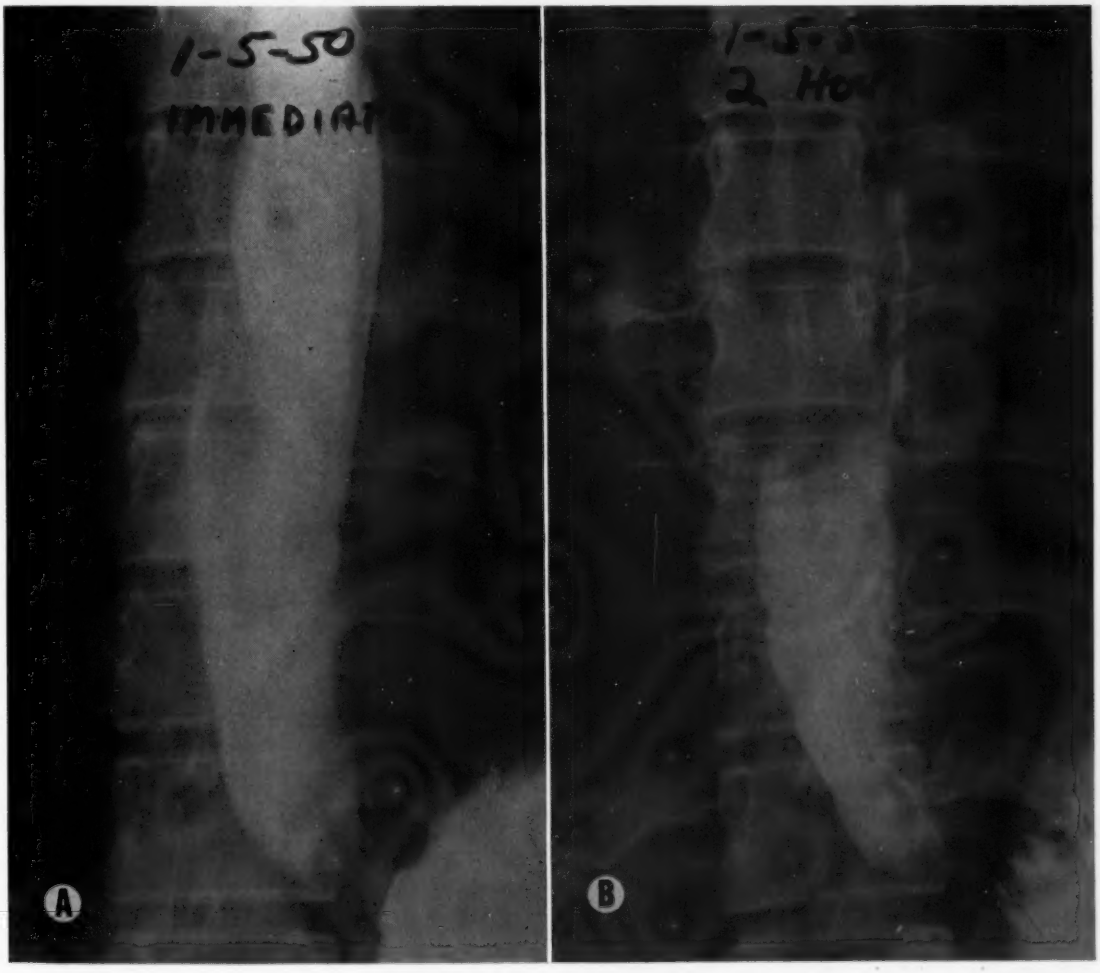

Fig. 13. Case P. S. Scleroderma, with calcinosis and bone absorption. White, female, aged forty-six, with disease for fifteen years. Biopsy positive. (*A*) (*B*) Roentgenograms showed soft tissue calcifications in pressure areas, and some absorption of tufts. Patient also had esophageal and duodenal involvement but, despite this, her general health was good.

Case P. S., a Greek female, aged forty-six, had the onset of her scleroderma fifteen years before her entry, with dysphagia being present for twelve years. Examination showed esophageal and duodenal involvement, with widening and delay in each site. The soft tissues of the fingertips and prepatellar areas showed calcinosis. Skin biopsy was interpreted as scleroderma. Her general health, three years later, is relatively good.

RHEUMATIC FEVER AND RHEUMATOID ARTHRITIS

We have reviewed some of the recent literature on rheumatic fever and rheumatoid arthritis, but have not analyzed in detail our cases of these diseases. Acute rheumatic fever is regarded as a collagenous degeneration which localizes selectively in the heart. The changes may be found in many other organs, as shown by the arthritic, dermal, serosal, intestinal and pulmonary manifestations of the disease. In acute fulminating form, pulmonary complications are reportedly found in as high as 50 per cent of cases.[8] "Rheumatic pneumonitis" has no specific diagnostic features, in our experience. Pericarditis is not uncommon. The involved joints tend to show only articular and periarticular swelling.

Rheumatoid arthritis is frequently complicated by myositis, neuritis and arteritis, as demonstrated in 70 per cent of muscle biopsies by Traut and Campoine.[20] Traut also states that these biopsies show aggregates of lymphocytes, epithelioid cells and plasma cells somewhat similar to those in dermatomyositis, lupus erythematosus and scleroderma. Pericarditis is the only unusually frequent cardica complication, being especially common in juvenile rheumatoid arthritis (Still's disease). In addition, a pneumonitis and pleuritis may occur along with the inflammatory reaction in the joints but is rare. The roentgen findings in the bones and joints of patients with rheumatoid arthritis are well known.

DISCUSSION

Collagen diseases constitute an interesting group of disorders—from the clinical side because of their diagnostic and therapeutic challenge, from the pathological viewpoint because of recent interest in the intercellular substances, and from the

roentgenological viewpoint because of their widespread but unfortunately nonspecific nature. The latter is particularly true of the pulmonary manifestations of the collagen diseases. We feel, however, that diagnostic possibilities, slim as they are, depend on an awareness of these conditions, plus a knowledge that the patient has a polysystemic disease. It is desirable that radiologists, as clinicians, be able occasionally to suggest the consideration of one of these diseases, on logical grounds, and be cognizant of the further studies, clinical, laboratory or pathological, required to confirm the diagnosis.*

From a review of our roentgenolgical findings, we believe that pulmonary changes occur more frequently in periarteritis nodosa and disseminated lupus erythematosus than one would gather from the literature. Further, from a survey of the histories of over 75 patients with established or clinically diagnosed collagen disease, we have the distinct impression that peptic ulcers occur with relatively greater frequency in these conditions than in the rest of the hospital population in general.

In studying a patient for possible collagen disease it is desirable that particular attention be paid to the following structures:

(a) The skin and muscles,
(b) The heart and pericardium,
(c) The lungs and pleura,
(d) The abdomen and intestinal tract,
(e) The kidneys, and
(f) The bones and joints.

The skin and muscles may show microscopic evidence of involvement in any of the four types of collagen disease discussed in this paper.† Histopathologic changes are reportedly fairly decisive in all except dermatomyositis, about which not enough is yet known; they are said to be most clear-cut in periarteritis, but there is divergence of opinion as to their clarity in scleroderma.

The cardiac and pleuropulmonary changes are many and nonspecific. Pericardial effusion, cardiac enlargement, pleural effusion, pulmonary nodular changes and variable degrees of pulmonary edema or fibrosis may occur. These changes may be reversible.

Abdominal distention, with paralytic obstruction, may occur in the first two conditions. Renal enlargement may also be seen in these two (periarteritis nodosa and disseminated lupus erythematosus).

The intestinal tract changes are most conspicuous in scleroderma, notably in the esophagus and small intestine (variable degrees of rigidity, dilatation and narrowing occur in about 50 per cent of cases).

The articular and osseous changes occur in periarteritis nodosa, lupus and especially scleroderma. Roentgenologically, they are characteristic only in the latter condition. Calcinosis is also confined largely to this disorder.

SUMMARY

We have reviewed currently accepted criteria concerning the pathology, classification and diagnosis of the so-called collagen diseases.

We have reviewed our personal experience with the roentgenological aspects of these diseases, and have summarized our findings in

28 cases of polyarteritis,
32 cases of generalized lupus erythematosus,
1 case of dermatomyositis, and
25 cases of scleroderma

In this entire group, pathologic material was available for study in 61 cases, and was interpreted as "positive" for the particular disease in question in 52 instances.

It is believed that awareness of the roentgenological findings in these disease entities will give the clinical radiologist greater opportunity for reaching or suggesting the correct diagnosis in everyday practice.

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* At the same time, it is believed that the term "collagen" disease is one of high abstraction, to be modified or abandoned as soon as the etiology and fundamental nature of these conditions becomes established.

† Periarteritis nodosa, disseminated lupus erythematosus, dermatomyositis and scleroderma.

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Vol. 71, No. 4

A CORRELATION OF ROENTGEN AND SURGICAL FINDINGS IN TWO HUNDRED CASES OF RHEUMATIC MITRAL VALVULAR DISEASE*

EVALUATION OF CARDIAC CHAMBER SIZE, VALVULAR CALCIFICATION AND PULMONARY VESSELS

By J. STAUFFER LEHMAN, M.D., *and* JOSEPH L. CURRY, M.D.
PHILADELPHIA, PENNSYLVANIA

THE present study was undertaken in an effort to evaluate the reliability of roentgen studies in assessing cardiac chamber enlargement, mitral valvular calcification and the size of pulmonary vessels. The recorded surgical observations of 192 cases operated on for the relief of mitral stenosis and 8 additional cases operated on for the relief of mitral insufficiency were reviewed. At surgery, the heart and great vessels were subjected to visual and palpatory examination. The interior of the left atrium and mitral valve area were examined by finger exploration in the course of mitral valve surgery.

Surgical observations were recorded as to the following: presence or absence and degree of cardiac chamber enlargement, pulmonary artery and vein enlargement, left atrial mural or thrombotic calcification, mitral valve calcification and the size and consistency of the mitral orifice. In addition, estimation of the presence and degree of mitral valve insufficiency was obtained by the actual regurgitant jet of blood impressed on the intra-atrial palpating finger during left ventricular systole. It was relatively impossible to obtain any accurate estimation of the size of the right atrium, since the operative approach has been through the left chest, according to the method of O'Neill, Glover and Bailey.[12] These data were compared with similar data obtained from preoperative roentgen studies. By such comparison we have attempted our own estimation of the value and limitations of certain roentgen findings and signs.

METHOD OF ROENTGEN STUDY

The roentgenologic preoperative evaluation of patients in this series had included careful roentgenoscopy in all angles of rotation with the patient in erect posture, and esophageal study using thick barium paste. The film studies have been obtained in posteroanterior projection with both normal and overpenetrated exposures at 72 inches; in right and left anterior oblique and left lateral projections at 48 inches, and in supine position at 36 inches. More recently we have added roentgen slit kymography obtained in upright posteroanterior projection and, on occasion, localized spot films of various exposure densities for valvular calcification. All of the conventional projections have been obtained at exposures of 1/20 second, with rare exceptions.

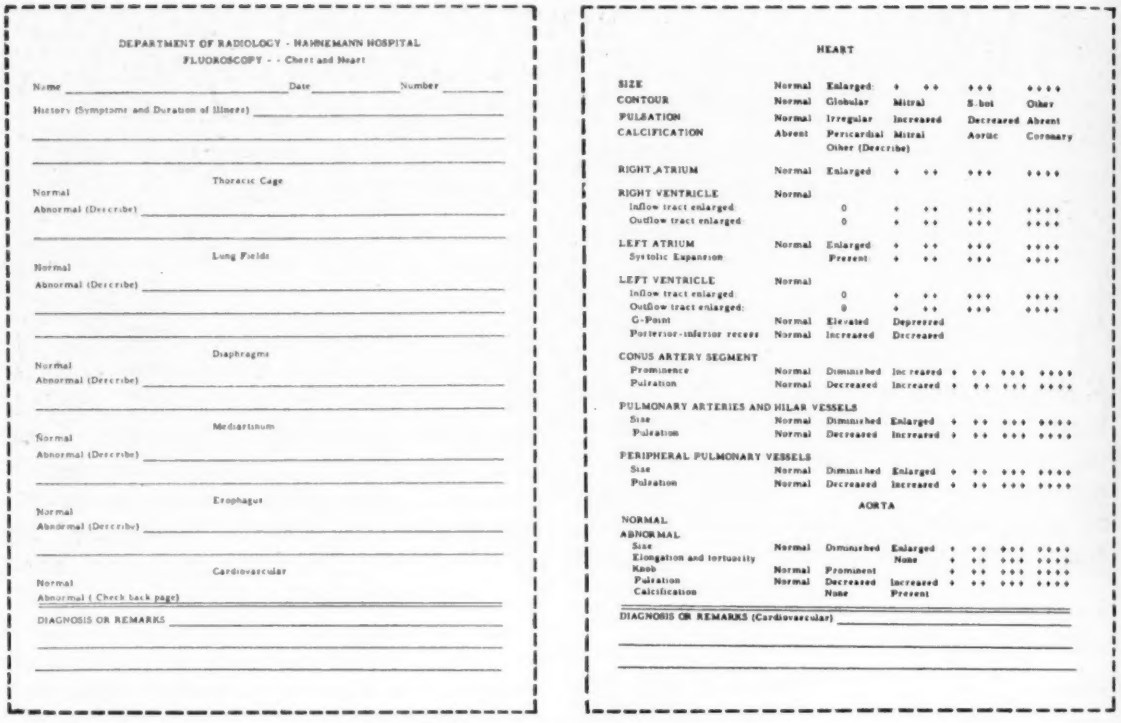
Roentgenoscopic observations were recorded on a notation form (Fig. 1). The roentgenoscopic findings were subsequently correlated with film observations for the final report on each case.

CARDIAC CHAMBER SIZE

With certain exceptions, the size of specific cardiac chambers can be estimated with a fair degree of accuracy by conventional roentgenoscopic and roentgenographic studies. The present study offers evidence that in mitral valvular disease the size of certain cardiac chambers may, at times, be difficult of evaluation.

Right Atrium. Surgical approach to the mitral valve through the left hemithorax by the method employed in our cases does not expose the right atrium for either visual

* From the Department of Radiology, The Hahnemann Medical College and Hospital, Philadelphia, Pennsylvania. Presented at the Fifty-third Annual Meeting, American Roentgen Ray Society, Houston, Texas, Sept. 23–26, 1952.



DEPARTMENT OF RADIOLOGY - HAHNEMANN HOSPITAL
FLUOROSCOPY - - Chest and Heart

Name _____ Date _____ Number _____

History (Symptoms and Duration of Illness) _____

Thoracic Cage
Normal
Abnormal (Describe) _____

Lung Fields
Normal
Abnormal (Describe) _____

Diaphragms
Normal
Abnormal (Describe) _____

Mediastinum
Normal
Abnormal (Describe) _____

Esophagus
Normal
Abnormal (Describe) _____

Cardiovascular
Normal
Abnormal (Check back page) _____

DIAGNOSIS OR REMARKS _____

HEART

SIZE	Normal	Enlarged:	+	++	+++	++++
CONTOUR	Normal	Globular	Mitral		S. bot	Other
PULSATION	Normal	Irregular	Increased		Decreased	Absent
CALCIFICATION	Absent	Pericardial	Mitral		Aortic	Coronary
		Other (Describe)				
RIGHT ATRIUM	Normal	Enlarged	+	++	+++	++++
RIGHT VENTRICLE	Normal					
Inflow tract enlarged:		0	+	++	+++	++++
Outflow tract enlarged:		0	+	++	+++	++++
LEFT ATRIUM	Normal	Enlarged:	+	++	+++	++++
Systolic Expansion		Present:	+	++	+++	++++
LEFT VENTRICLE	Normal					
Inflow tract enlarged:		0	+	++	+++	++++
Outflow tract enlarged:		0	+	++	+++	++++
C-Point	Normal	Elevated	Depressed			
Posterior-inferior recess	Normal	Increased	Decreased			
CONUS ARTERY SEGMENT						
Prominence	Normal	Diminished	Increased	+	++	+++ ++++
Pulsation	Normal	Decreased	Increased	+	++	+++ ++++
PULMONARY ARTERIES AND HILAR VESSELS						
Size	Normal	Diminished	Enlarged	+	++	+++ ++++
Pulsation	Normal	Decreased	Increased	+	++	+++ ++++
PERIPHERAL PULMONARY VESSELS						
Size	Normal	Diminished	Enlarged	+	++	+++ ++++
Pulsation	Normal	Decreased	Increased	+	++	+++ ++++

AORTA

NORMAL						
ABNORMAL						
Size	Normal	Diminished	Enlarged	+	++	+++ ++++
Elongation and tortuosity			None	+	++	+++ ++++
Knob	Normal	Prominent		+	++	+++ ++++
Pulsation	Normal	Decreased	Increased	+	++	+++ ++++
Calcification		None	Present			

DIAGNOSIS OR REMARKS (Cardiovascular) _____

FIG. 1. Roentgenoscopic notation form.

or palpatory examination. Forward displacement and "squashing" of the right atrium by an enlarged left atrium have been described,[23] and increased salience of the right atrial contour, in frontal projections, may imply enlargement of a normal right atrium. This may be exaggerated further by right ventricular enlargement, producing additive displacement of the right atrium (Fig. 2). In our experience, identification of an elongated right atrial appendage, in left anterior oblique projection,[16] is usually impossible in advanced mitral stenosis, due to superimposition of the enlarged right ventricle. In the smaller "mitral" heart, with little or no right ventricular inflow tract enlargement, this problem does not exist, but obviously right atrial enlargement is not expected in such a case. In the absence of clinical evidence of congestive heart failure or tricuspid valvular disease, we have used considerable reservation before indicating enlargement of the right atrium.

Right Ventricle. Accuracy in predicting enlargement of this chamber seems high and has presented little difficulty. The established criteria have served us well.[14,16,22] Exaggerated anterior convexity of the right ventricular outflow tract as seen in lateral and right anterior oblique projections in mitral stenosis is often a function of both right ventricular enlargement and forward displacement of the right ventricle by the enlarged left atrium. Angiocardiographic analysis has demonstrated this,[4,7] and forward displacement of the anterior wall of the left atrium is noteworthy as estimated by the palpating finger within the left atrium.

All cases explored in this series, without exception, presented surgical evidence of right ventricular enlargement as well as enlarged pulmonary arteries.

Left Atrium. Perhaps the most measurable evidence of left atrial enlargement is esophageal displacement. It is well known that considerable posterior displacement of the esophagus occurs before right lateral deviation is evident. Infrequently, left

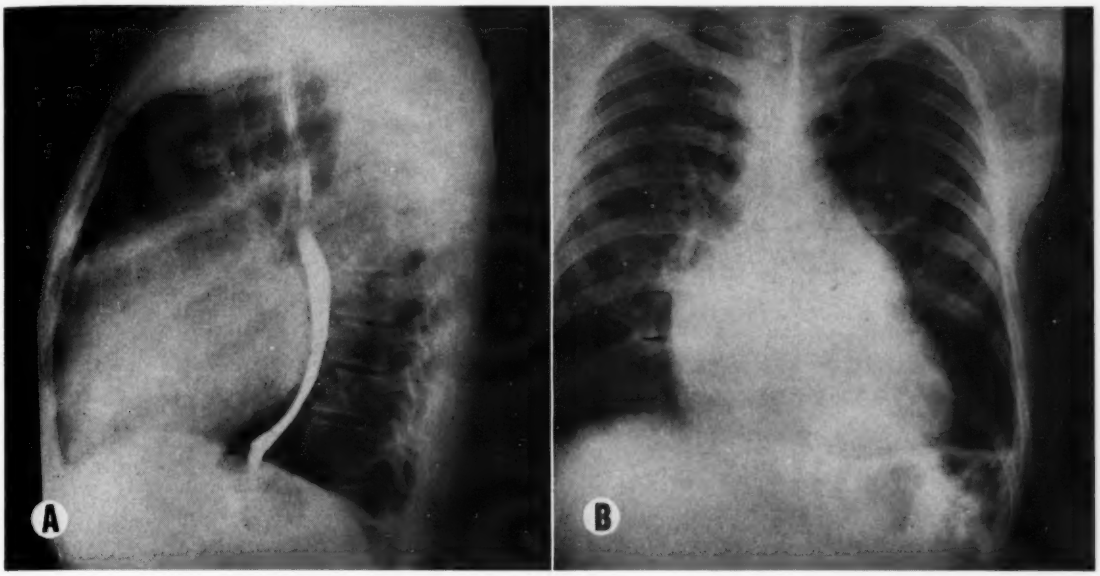


Fig. 2. Prominence of the right atrial margin presumably due to "squashing" by enlarged left atrium, as well as lateral displacement by enlarged right ventricle. "Pure" mitral stenosis found at surgery.

posterolateral displacement of the esophagus occurs with left atrial enlargement,[14,16] and was demonstrated in 2 of our cases (1 per cent).

Elevation of the left main bronchus is a well established finding in left atrial enlargement, and with marked left atrial enlargement both main stem bronchi and pulmonary arteries may be raised cephalad. The factor of enlarged interposed pulmonary veins which lie between the left bronchus and enlarged atrium has been elicited by angiocardiographic study.[4] We have thus far found no case in which left bronchial elevation due to left atrial enlargement existed in the absence of definite esophageal displacement.

Identification of the so-called left infrabronchial space, said to be obliterated early in left atrial enlargement,[22] has been of no assistance in our study. We are often unable to distinctly identify this space in normal individuals.

The degree of carinal widening has generally paralleled the magnitude of left atrial enlargement, but the shape assumed by the elevated left bronchus seems variable[15] and is of no presumed significance other than its over-all elevation. As might be expected, the degree of carinal widening has also generally paralleled the degree of esophageal displacement.

It has been said that left atrial enlargement usually produces posterior esophageal displacement, which ends well above the diaphragm.[21] While this is generally true, certain of the larger left atria in this series have extended to the diaphragm posteriorly and intruded into the posteroinferior cardiac recess (Fig. 3).

The degree to which the left atrium enlarges in mitral stenosis is not only dependent on the degree of valvular stenosis but is also determined by pathologic changes within the left atrial wall, as has been emphasized by Nichols and Ostrum and others.[3,10,11] The data from our series support this observation. Although there has been some element of left atrial enlargement in all of these 200 cases, there has been no close correlation between the degree of mitral stenosis and the amount of left atrial enlargement.

Left Ventricle. In cases of combined mitral stenosis and insufficiency, where the degree of insufficiency is in doubt, roentgen clarification of left ventricular size may be of critical value.[14,16,19] In some cases, this

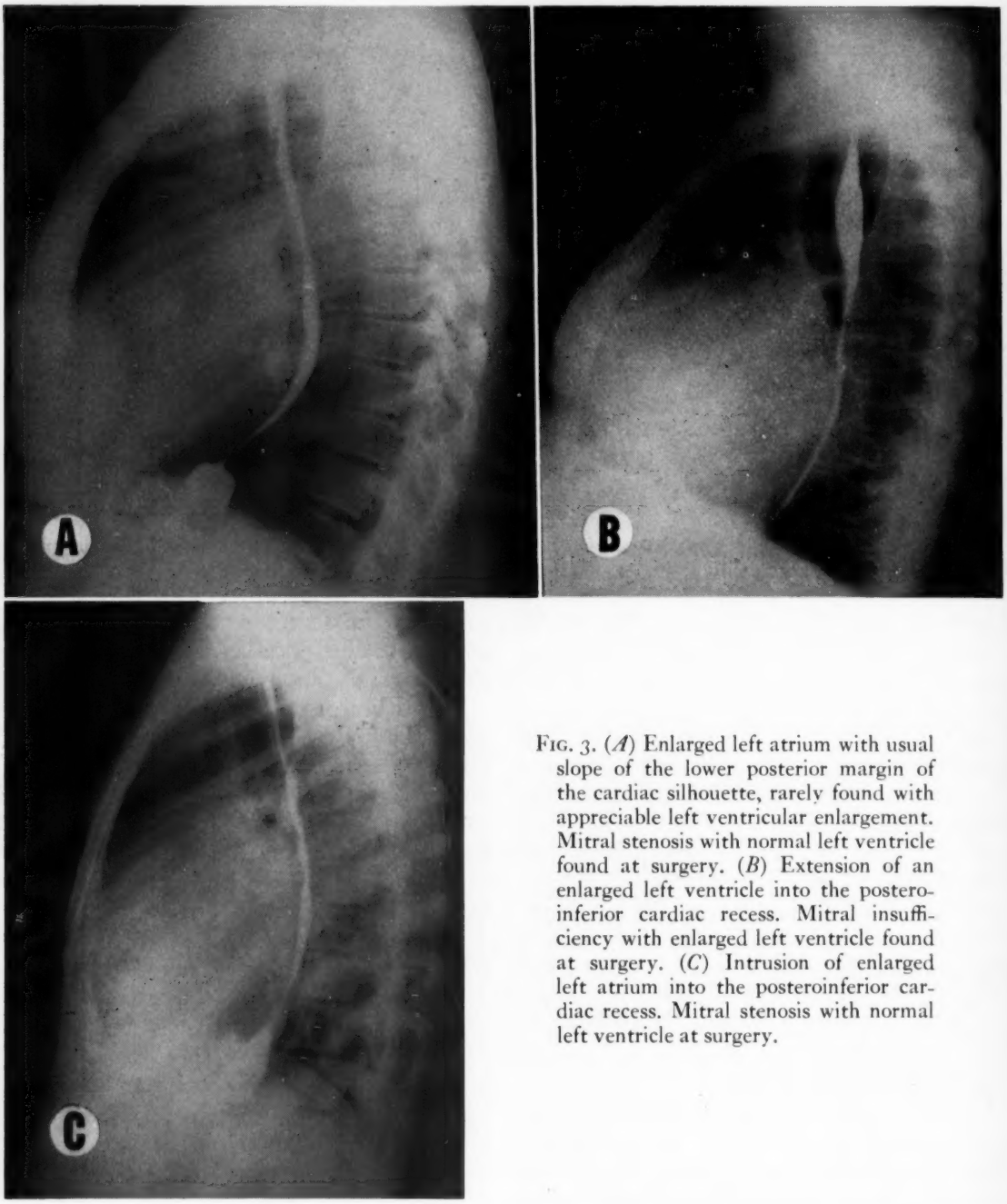


Fig. 3. (*A*) Enlarged left atrium with usual slope of the lower posterior margin of the cardiac silhouette, rarely found with appreciable left ventricular enlargement. Mitral stenosis with normal left ventricle found at surgery. (*B*) Extension of an enlarged left ventricle into the posteroinferior cardiac recess. Mitral insufficiency with enlarged left ventricle found at surgery. (*C*) Intrusion of enlarged left atrium into the posteroinferior cardiac recess. Mitral stenosis with normal left ventricle at surgery.

may be extremely difficult, and in our hands certain existing criteria are of limited value.

In our experience definite identification of the position of the cardiac "apex" in frontal projection, and occasionally by overpenetrated supine film is the most reliable single guide in assessing left ventricular size (Fig. 4). In many "mitral" hearts specific localization of the point of differential pulsations on the left heart border in frontal projection has proved difficult. It is our firm conviction that the factors of left posterior cardiac rotation and intrusion of an enlarged main pulmonary artery into the left cardiac "waist" can obscure

the true anatomic point of differential pulsations.[7]

Posterior displacement and rotation of a normal left ventricle by an enlarged right ventricle are well known.[14,16] This left ventricular displacement phenomenon often suggested left ventricular enlargement subsequently proved to be nonexistent (Fig. 5*A*). The degree of uncertainty has usually varied directly with the magnitude of right ventricular and left atrial enlargement. Not only is the left ventricle displaced posteriorly by the enlarged right ventricle, but the enlarged left atrium forms variable portions of the lower left cardiac border in left anterior oblique projections. Infrequently, a differential groove will serve to segregate the left ven-

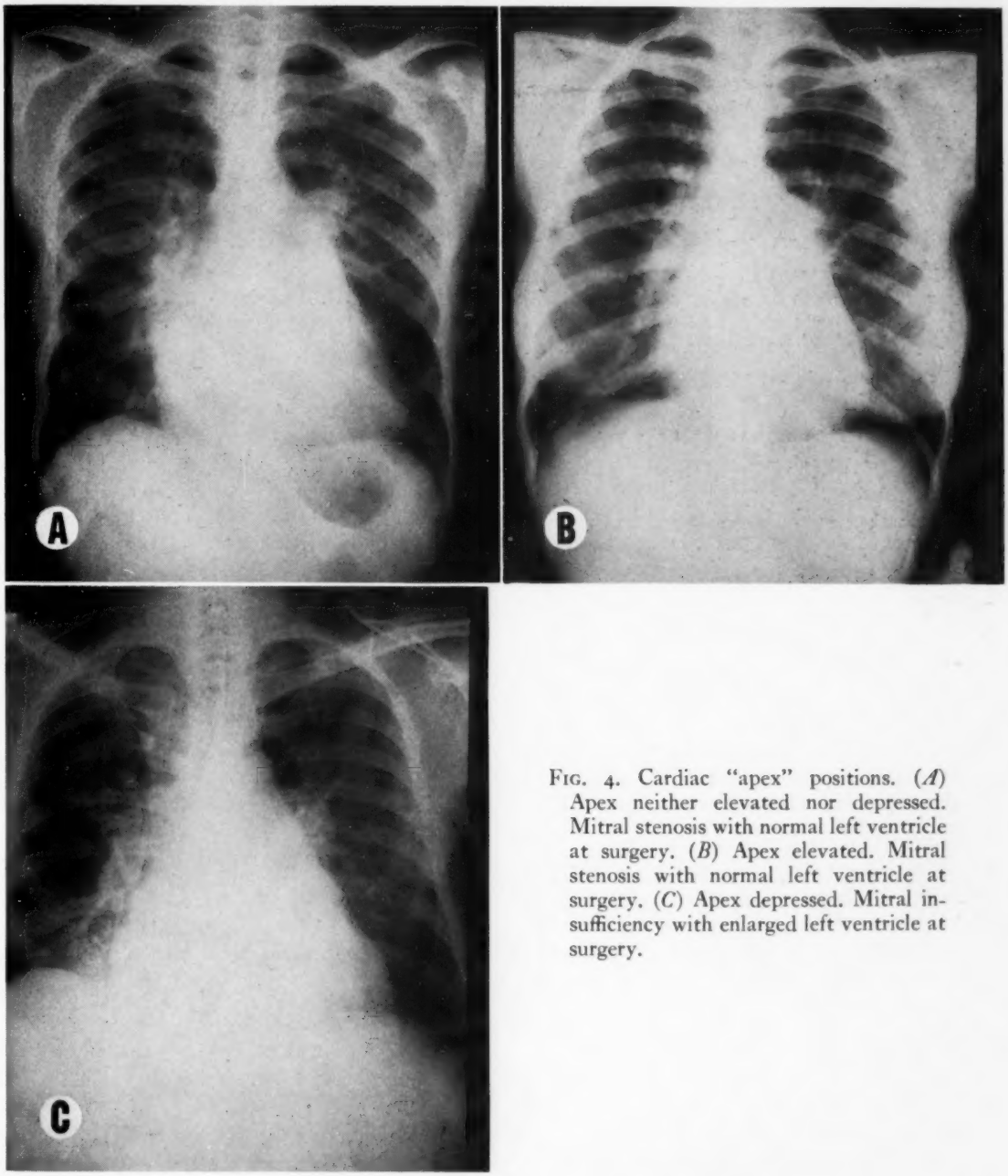


Fig. 4. Cardiac "apex" positions. (*A*) Apex neither elevated nor depressed. Mitral stenosis with normal left ventricle at surgery. (*B*) Apex elevated. Mitral stenosis with normal left ventricle at surgery. (*C*) Apex depressed. Mitral insufficiency with enlarged left ventricle at surgery.

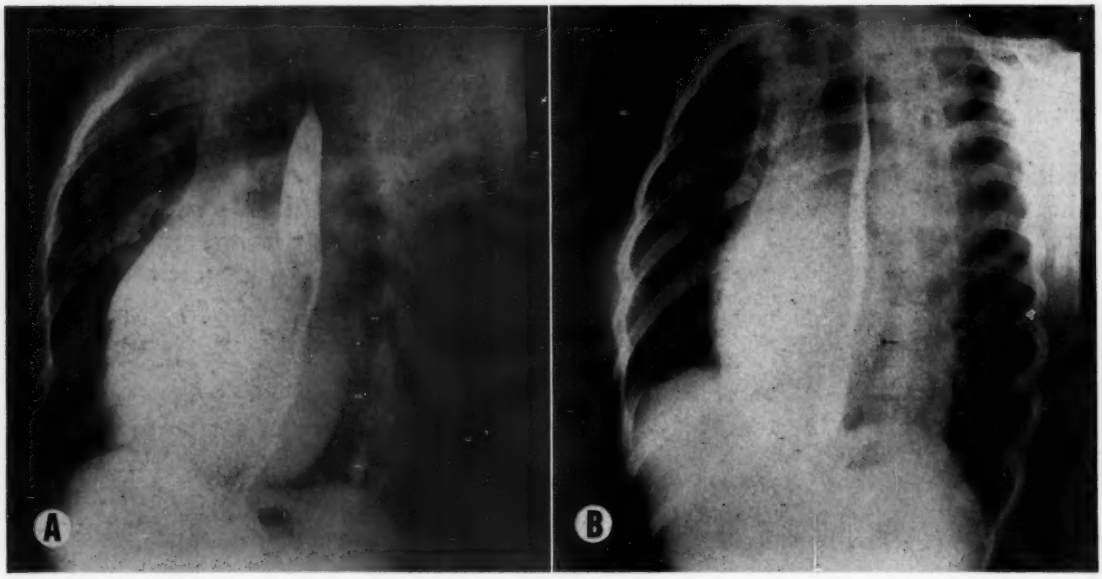


Fig. 5. Left ventricular displacement in mitral disease. (*A*) Normal left ventricle rotated and displaced posteriorly by enlarged right ventricle (left anterior oblique projection). Marginal limitations of the left atrium and left ventricle are indeterminate (proved case of mitral stenosis with normal left ventricle). (*B*) Differential groove segregates the left ventricle and enlarged left atrium (proved case of mitral stenosis with normal left ventricle).

tricle and the enlarged left atrium in this projection (Fig. 5*B*).

In the larger left atria, downward extension may actually intrude into the posteroinferior cardiac recess, simulating obliteration of this space by left ventricular enlargement (Fig. 3*C*). The presence of a normal posteroinferior cardiac recess has proved helpful in excluding appreciable left ventricular enlargement, but obliteration of this space is by no means pathognomonic of left ventricular enlargement. Such entities as huge left atrium, vena caval shadow (ill defined), pericardial effusion, pectus excavatum and altered diaphragmatic contour may produce partial or total obliteration of this space.

Preservation of a clear posteroinferior cardiac recess is not unusual in cardiac disease in which the predominant chamber enlargement is left ventricular, such as hypertensive cardiovascular disease, aortic valvular disease and coarctation of the aorta. The observations which we have indicated above regarding the helpfulness of a clear posteroinferior cardiac recess in excluding appreciable left ventricular enlargement appears to apply to cardiac enlargements which have, as a predominant feature, some element of right ventricular (and left atrial) enlargement, and in which there is some counterclockwise rotation of the heart. The observation does not apply to situations in which the basic enlargement is left ventricular.

Prediction of left ventricular enlargement, based on the position of the interventricular notch[16] has been of no assistance to us in this series as it could be questionably defined in only 1 per cent of cases. In this regard we share the opinion of other investigators,[21] and cannot often identify this notch with absolute certainty in normal hearts.

In "mitral" hearts, if the posteroinferior cardiac recess is obliterated and the exact position of the cardiac "apex" is not clearly definable, we are unable to predict the size of the left ventricle.

MITRAL VALVULAR CALCIFICATION

Deposition of calcium in the mitral valve as a late result of rheumatic valvulitis involves the orificial margins often as small

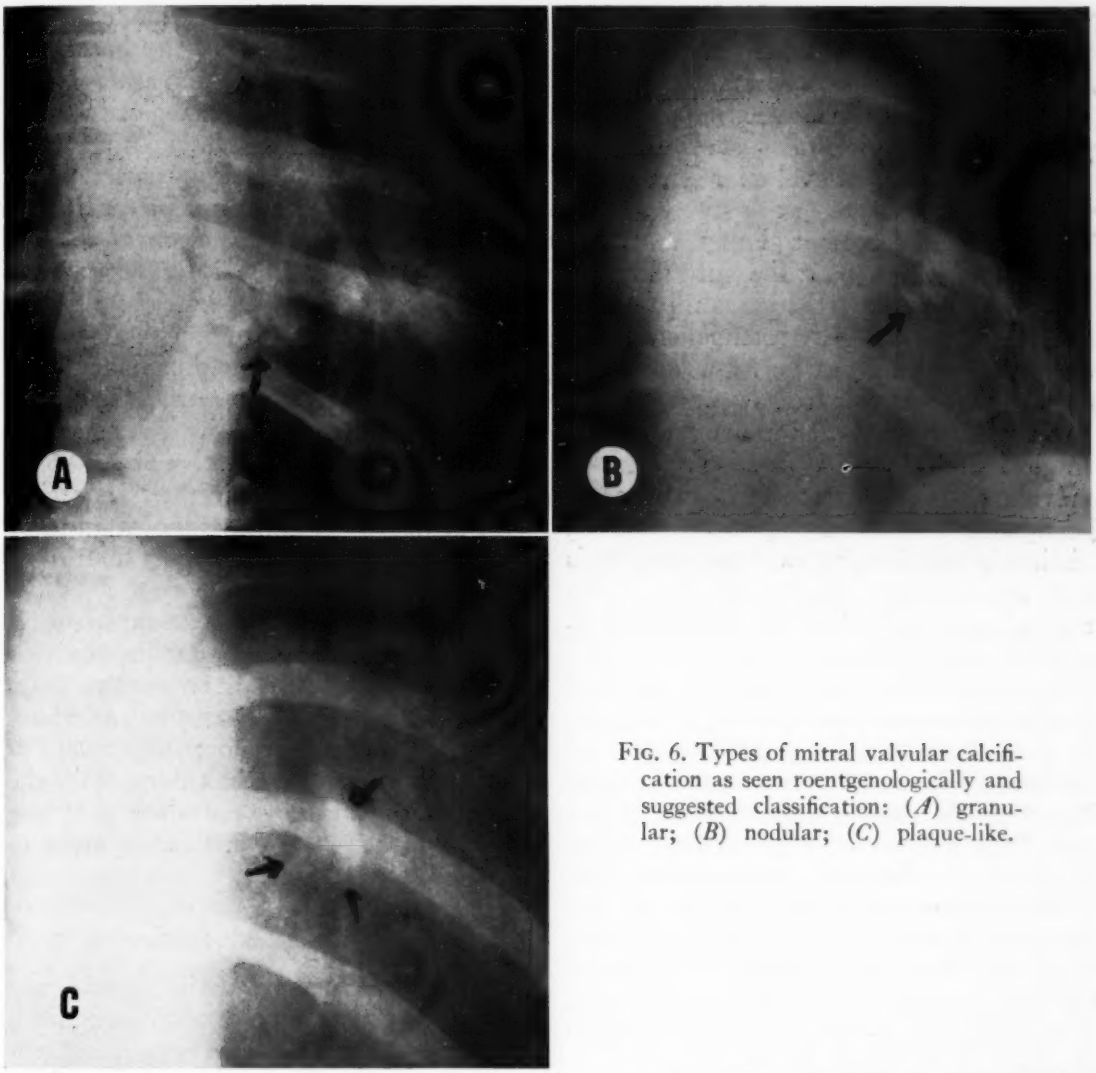


Fig. 6. Types of mitral valvular calcification as seen roentgenologically and suggested classification: (*A*) granular; (*B*) nodular; (*C*) plaque-like.

particles, as block-like masses at either commissure, or as a general infiltration of the valve substance.[1] The valve roots are usually free of calcium at their annular insertion.[2] On the other hand, in the mitral area, dystrophic changes occurring as a degenerative process with secondary calcification tend to involve the left annulus, although calcification may spread into the valve roots. It has also been stated that the associated atherosclerotic process is most pronounced on the ventricular surface of the mitral valve.[14] Calcific deposits in the annulus fibrosum are often large and may assume a U- or J-shaped appearance.[16]

Roentgenoscopic visualization of elliptical, oscillatory motions of calcium within the mitral area has been carefully described,[2] and serves as a reliable guide. The amplitude of motion of calcium within the mitral valve varies considerably and is presumably related to varying degrees of valvular fixation and deformity.

Roentgenologic Observations. We have roentgenologically observed mitral valvular calcification, the appearance and distribution of which have suggested the following classifications: (a) granular, (b) nodular, and (c) plaque-like (Fig. 6).

Obviously, combinations of these types exist as seen roentgenologically and occasional cases defy adequate description. Such classification, while of reference usefulness, seems of limited value to the surgeon, who

is primarily interested in distribution and amount of calcium deposition. While a rough roentgenologic estimation of the extent of valvular calcification might seem justifiable, this series has shown that a variable portion of valvular surface is usually calcium-free at surgery, even though roentgenograms imply extensive calcification throughout the mitral area.

In these 200 reported cases mitral valvular calcification was roentgenologically demonstrated in 64 cases. Actual valvular calcification was palpated at surgery in all but 2 of these cases. In these 2 cases the surgical findings were those of extensive valvular scarring. After reviewing the roentgenograms with the surgeons we have the distinct impression that the extent of fibrosis and scarring precluded palpatory detection of calcium which was probably embedded deeply in scar tissue.

In 10 additional cases, calcium was surgically but not roentgenologically detected. In 8 of these calcium deposition seemed minimal to the exploring intra-atrial finger. We can only conclude that such minimal deposition is often roentgenologically "invisible." Admittedly, roentgenologically "visible" calcium deposition will escape the observer through lack of constant vigilance. While primary reliance is centered on roentgenoscopy, we have found that a 36 inch supine, overpenetrated film study obtained at 1/20 second is of distinct value in detection of mitral valvular calcification.

PULMONARY VESSELS

Careful roentgenoscopy and roentgenographic study in these 200 cases reveal that the peripheral pulmonary vessels can be described as roentgenologically normal in the absence of heart failure, regardless of the duration or stage of the disease, in contrast to the frequent surgical finding of enormous main pulmonary arteries. This correlation of surgical and roentgenological findings has revealed that roentgen prediction usually underestimated the size of the major pulmonary arteries. Our explanation of this discrepancy is the fact that the main pulmonary artery is partially hidden within the shadow of the base of the heart, and except for a portion of its anterolateral margin it is not roentgenologically definable. Right and left main pulmonary arteries accessible to surgical inspection are likewise masked by features of cardiac enlargement. Surgical evaluation of the size of the intermediate and smaller branch vessels was not possible since these vessels are clothed in lung tissue.

Inasmuch as the larger pulmonary veins occupy a rather central retrocardiac position and are not ordinarily roentgenologically definable, no correlative observations have been recorded. Nevertheless, surgical data in all 200 cases have indicated some degree of pulmonary venous dilatation. This finding does not support the contention that the enlarged left atrium in mitral stenosis may serve a reservoir function with very little pulmonary venous overfilling.[14] Apropos of this, Dotter and Steinberg[4] have noted angiocardiographically that the pulmonary veins enlarge with the left atrium and they postulate that the pressure must rise within them in order to maintain a blood flow.

Left Atrial Calcification

Five instances of left atrial calcification were encountered in these 200 cases, and 3 additional cases have since been found. All of these cases are the subject of a separate study and report.

The Roentgenologic Problem of the Prediction of Mitral Insufficiency

When there is clinical uncertainty as to the presence and degree of mitral insufficiency, specific interest is focused on roentlogic aid. Roentgenologic aid in attempting to resolve this problem may logically consider three issues: prediction of the size of the left ventricle, presence or absence of so-called systolic expansion of the left atrium, and kymography.

Left Ventricle. Left ventricular enlargement should accompany a significant ele-

TABLE I

SURGICALLY DETECTED MITRAL REGURGITATION CORRELATED WITH LEFT VENTRICULAR SIZE. INFLUENCE OF LEFT VENTRICULAR SIZE ON CARDIAC "APEX" POSITION AND THE POSTEROINFERIOR CARDIAC RECESS

	Surgical Findings				Roentgen Findings				
	Regurgitation				Cardiac apex			Posteroinferior cardiac recess	
	None	Minimal	Moderate	Marked	Normal or elevated	Depressed	Position uncertain	Normal	Obliterated
Left ventricle—normal 165 cases	134	27	4	0	147	8	10	140	25
Left ventricle—enlarged 35 cases	3*	10†	14	8‡	9	23	3	4§	31

* Two of these cases presented evidence of aortic stenosis.
† Three of these cases had aortic valvular lesions.
‡ Although operated on for relief of mitral insufficiency, existence of preponderant insufficiency was clinically and roentgenologically uncertain before sugery in 3 cases.
§ In 3 of these cases, left ventricular enlargement was minimal.

ment of mitral insufficiency. However, surgical data of our cases have demonstrated that minor degrees of insufficiency are unassociated with left ventricular enlargement (Table 1). The problems encountered in predicting left ventricular size have already been discussed.

Systolic Expansion of Left Atrium. Expansion of the left atrium, occurring simultaneously with left ventricular systole, has been considered a somewhat reliable indication of mitral insufficiency.[8,14] We have become increasingly interested in roentgenoscopic demonstration of this phenomenon, but did not diligently search for its presence in the earlier cases of this series. The recent publication of Elkin *et al.*[5] brings to point the apparent value of careful roentgenoscopy in search of this sign. Isolated instances, at this time not lending themselves to our statistical analysis, give us concern as to its reliability in predicting mitral insufficiency in any specific case. We are thus far impressed that absence of this finding does not rule out significant mitral regurgitation.

Kymography. The limitations of multiple slit roentgen kymography have been considered by various investigators.[6,8,17] The unusual opportunity presented by an abundance of mitral valvular lesions subjected to surgery has prompted us to re-evaluate the possible diagnostic value of this procedure. In particular, this interest was stimulated in search of an added mechanism which might further contribute to the identification of patients with appreciable mitral insufficiency and therefore unsuitable for mitral commissurotomy. Thus, this study has been devoted to a search for roentgen kymographic signs of mitral insufficiency, with special reference to left ventricular filling waves and "systolic expansion" of the left atrium occurring simultaneously with left ventricular systole.

It has been cited[8] that considerable functional valvular disease must exist in order to produce the typical slow left ventricular filling wave of mitral stenosis, or the initially rapid left ventricular filling wave of mitral insufficiency as described by Hirsch and Gubner.[9] Obviously "systolic expansion" of the left atrium in mitral insufficiency may be influenced by a number of factors, with special reference to the consistency of the atrial wall and transmitted motions.[5]

In a series of 100 cases of mitral valvular disease admitted as possible candidates for surgery, multiple slit kymograms were obtained in posteroanterior projection, with the patient in upright posture. Eight cases

of severe mitral insufficiency were included in this series. In selected cases where left posterior cardiac rotation seemed maximal, roentgen kymograms were also secured in the left anterior oblique projection with varying degrees of obliquity, in an attempt to secure a more dependable left ventricular wave pattern. Left atrial wave patterns as obtained in right anterior oblique projections were usually indistinct and rarely helpful in detection of "systolic expansion" forming in mitral hearts. Aortic waves were usually observed in order to insure a relatively normal or low amplitude pattern consistent with isolated mitral disease. In all instances clinical data were carefully reviewed in regard to the possible presence of an aortic valvular lesion. In cases of clinically suspected aortic insufficiency in which the aortic kymographic waves were of wide amplitude with rapid retraction, no attempt was made to evaluate the left

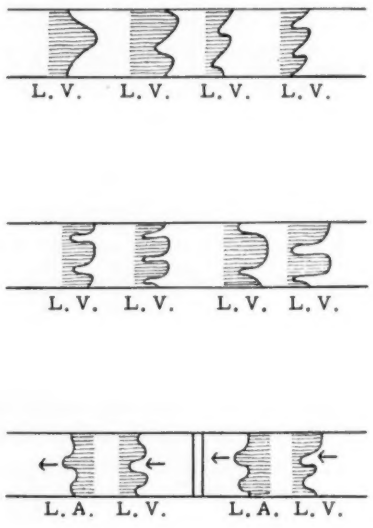

Representative left ventricular diastolic filling wave varying from normal to a slow rise, the latter said to occur in mitral stenosis. These were seen in 60 proved cases of mitral stenosis, but also in 6 proved cases of mitral insufficiency.
L. V. L. V. L. V. L. V.
Representative left ventricular diastolic wave of rapid rise said to occur in mitral insufficiency. These were seen in only 2 of 8 proved cases of mitral insufficiency but were also seen in 14 of 74 cases of proved mitral stenosis.
L. V. L. V. L. V. L. V.
Representative left atrial "expansion" waves occurring simultaneously with left ventricular systole said to occur in mitral insufficiency. These were seen in 4 of 8 proved cases of mitral insufficiency, but also in 5 of 74 proved cases of mitral stenosis.
L. A. L. V. L. A. L. V.
L. V. = Left ventricle
L. A. = Left atrium

FIG. 7. Representative tracings of selected frames from multiple slit kymograms in 74 cases of mitral stenosis and 8 cases of mitral insufficiency. The flow of time is upward. Left ventricular frames were selected from the approximate mid-portion of the left ventricular outflow tract.

of the left atrium. In this situation, frontal projections were more helpful when the enlarged left atrium reached the right heart border. In the presence of atrial fibrillation we were usually unable to evaluate roentgen kymograms of varying wave forms.

The use of frontal projections in most cases seemed justified by the surgical finding that the right ventricle rarely approached the left heart border, and a review of published angiocardiographic studies in mitral stenosis[4,7] demonstrates that the right ventricle is not usually border-

ventricular waves in regard to the functional status of the mitral valve. Evidence of left atrial "systolic expansion" was sought in all cases.

Results. Mitral Insufficiency: In 8 cases of preponderant insufficiency explored for possible surgical relief, typical left ventricular waves characterized by an initially rapid diastolic rise were encountered in only 2 cases (Fig. 7). In 4 cases, all of which lacked a typical ventricular filling wave, clearcut evidence of left atrial "diastolic filling" was found. As indicated by others,[5]

absence of this phenomenon in no way excludes the presence of significant mitral insufficiency.

Mitral Stenosis: Multiple slit kymograms were obtained in 92 cases of mitral stenosis. At surgery 23 of these cases were found to have associated minimal degrees of mitral insufficiency. The left ventricle was enlarged slightly in only 5 cases and in 3 of these associated aortic stenosis existed. The 3 cases with aortic valvular lesions were then excluded from this analysis because of the unknown influence which the aortic lesion might bring to bear on the kymographic wave pattern. It was of further interest that 2 cases which revealed clinical and surgical evidence of a tight mitral stenosis and aortic stenosis presented no surgical evidence of left ventricular enlargement. This was presumably due to the mitral stenosis which limited the volume of blood entering the left ventricle, although the latter was contracting against the resistance of a stenotic aortic valve. Fifteen additional cases were excluded because of indistinct kymographic waves, 10 of which had atrial fibrillation.

In the remaining 74 cases, 60 presented a left ventricular filling wave which showed varying degrees of slow diastolic rise, in some cases closely simulating the normal (Fig. 7). The degree of stenosis did not parallel the attenuation of diastolic rise and in 14 cases a rapid diastolic rise suggestive of mitral insufficiency was demonstrated. Of these 14 cases depicting a roentgen kymographic pattern of rapid left ventricular diastolic filling, 11 were surgically tight stenoses and 3 cases presented minimal regurgitant jets to the palpating surgical finger. Of further interest was the finding of apparent "systolic expansion" of the left atrium, kymographically, in 5 cases of mitral stenosis, 3 of which were "pure."

In view of these observations we can only conclude that slit roentgen kymography is of little aid in detection of mitral insufficiency in any individual case. Similar limitations involving the use of electrokymography are also suggested in recent reports of Soloff, Zatuchni and Stauffer[18] and Phillips.[13]

SUMMARY AND CONCLUSIONS

1. Correlated roentgen and surgical findings are presented in 192 cases explored for the relief of mitral stenosis and in 8 cases where surgical efforts were directed to the relief of mitral insufficiency as the dominant lesion.

2. Since the right atrium is not examined at mitral valve surgery by the method cited in these cases, no correlative data are reported. Nevertheless, difficulties in roentgenologic estimation of right atrial size are reviewed.

3. Roentgenologic estimation of right ventricular enlargement seems reasonably accurate, although the degree of prominence of this chamber contributed by the displacing effect of an enlarged left atrium is probably indeterminate without angiocardiography.

4. The larger left atria may extend downward and intrude into the posteroinferior cardiac recess. Carinal widening, in general, parallels the degree of esophageal displacement in left atrial enlargement, but the shape assumed by the displaced bronchi has no correlation with the degree of left atrial enlargement.

5. Obliteration of the posteroinferior cardiac recess by factors other than left ventricular enlargement and inability to identify the so-called interventricular notch have contributed to difficulties in predicting left ventricular size. In many "mitral" hearts the position of the point of differential pulsations on the left heart border has been difficult to identify. The position of the cardiac apex has been our most reliable single guide in predicting left ventricular size.

6. Accuracy of roentgenologic detection of mitral valve calcification has been high in this series as confirmed by surgical exploration. A classification of roentgenologic appearances of mitral valvular calcification is presented.

7. The size of major pulmonary vessels,

visible to the surgeon, was usually underestimated by roentgen observations. Possible reasons are cited.

8. Determination of the presence and degree of mitral insufficiency in clinically uncertain cases presents a roentgenologic problem. Estimation of left ventricular size is important but often difficult in larger hearts. Systolic expansion of the left atrium, when present, is a possible but unreliable guide. Multiple slit roentgen kymography has proved discouraging as a possible contribution to the solution of this problem.

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DISCUSSION

Dr. J. E. Miller, Dallas, Texas. It is very obvious after reading the complete paper that Dr. Lehman and Dr. Curry have had a wide experience evaluating the roentgen manifestations of heart disease and in particular mitral valvular disease. I would like to spend the entire time allotted to me pointing out areas of agreement and perhaps occasionally enlarging on the authors' comment. Certainly, the major part of the paper could be handled in this way. At the risk of being querulous, however, I would like to take the points where I may find slight differences with the authors and dwell on these.

The authors indicate that the data obtained by the surgeon were compared with the data

obtained by the preoperative roentgen studies. It is perfectly logical, of course, to question whether or not the surgeons at the time they are observing the heart by all of their techniques can evaluate the chamber size with a high degree of accuracy. It is my impression that the anatomy as seen by the surgeons with the thorax opened and with dynamics changed is different from the anatomy one sees roentgenologically. This would be especially true in evaluating the size of the pulmonary vessels. There may be as much difference between the anatomy the surgeon sees and roentgen anatomy as between the anatomy one sees in the anatomy lab on the static fixed cadaver and surgical anatomy.

On two occasions the authors refer to "careful roentgenoscopy." In evaluating their method of roentgenoscoping the patient and also the films that they take, there is no doubt that their examination rates the word careful. This of course implies that they and others are not always careful with their examinations. Using this line of reasoning on myself I must admit that the authors' use of the word careful applies. I certainly do not go to the extremes of evaluating the heart that they do and of course am wondering if I slight this examination.

I am particularly pleased to note that they find the size of certain cardiac chambers difficult of evaluation. I certainly have found it so to such an extent that I now feel cheated in evaluating the cardiac silhouette if I do not have some information concerning the electrocardiogram. The same, of course, is true for cyanosis in patients with congenital heart disease. In looking back over my reports of evaluation of chamber size by conventional means and then comparing these with angiocardiograms the errors have been too frequent to warrant any complacency in my ability to evaluate chamber size.

The authors leave out my favorite word in discussing chamber size and that is stressing that the chamber is "disproportionately" enlarged. We all see many hearts that are larger than normal and are unable to ascertain whether one or more chambers are disproportionately enlarged. It is chambers that are disproportionately enlarged that give information concerning anatomical abnormalities. One can say very little about a heart if it is generally enlarged and there is no evidence of disproportionate chamber enlargement.

It is apparent that the authors have as much difficulty as others in evaluating right atrial enlargement and that it helps them little at all in cardiac diagnosis.

I also noted that the authors' reference to patients having mitral stenosis is placed in quotation marks. I have the courage to say that the term "mitral configuration" and "mitral heart" should be abandoned by those able to evaluate the cardiac silhouette roentgenologically. I can name nine different conditions in which the tyro will look at the frontal projection of the chest and utter the words "mitral configuration." This does not include the atypical type of heart disease where the same configuration is present. This being true, the term mitral configuration has no meaning insofar as the pathologic process is concerned.

I was somewhat surprised to see the infrequency with which displacement of the esophagus to the left in left atrial enlargement occurred in this series. I have seen it twice within this present month and of course can recollect having seen it other times during the past several years. While I have had opportunity to see more than 200 patients with disproportionate atrial enlargement during this interval of time my impression is that this phenomenon is more frequent than 1 per cent.

I used to think that the left anterior oblique evaluation of disproportionate ventricular enlargement was best. I now find myself going back to the frontal projection in order to ascertain whether or not the left ventricle is disproportionately enlarged. I am particularly pleased to see that the authors apparently do the same thing. Since aortic stenosis and aortic insufficiency occur in patients with rheumatic heart disease, there are three good reasons why the left ventricle might become disproportionately enlarged. In patients who have mitral stenosis I feel I have accomplished something if I have accurately evaluated also disproportionate left ventricular enlargement. I must invade the field of clinical medicine to ascertain whether or not it is due to mitral insufficiency rather than the other possibilities mentioned. Consultation with the clinician, however, usually relieves me of this dilemma.

I agree with the authors that prediction of left ventricular enlargement based on the position of the interventricular notch is foolishness. Anyone who has done angiocardiography is aware of this.

The authors' conclusion that slit roentgen kymography and electrokymography are of little aid in detection of mitral insufficiency would parallel the experience we have had but admittedly that experience is small.

It has been a distinct privilege to discuss this paper and I can assure you that I have learned techniques which I plan to try.

DR. LEHMAN (closing). I have very little to add and I certainly thank Dr. Miller for his discussion. I believe he was quite kind to me, as I really expected some fireworks.

Regarding surgical accuracy, we were of course originally in doubt as to whether the surgeons could, with a reasonable degree of accuracy, define the extent and degree of chamber enlargement. We have brought this problem up a number of times at our regular Heart Conferences. We purposely selected these 200 cases from the tail end of about 1,000 commissurotomies. These gave us enough experience, with enough autopsies, to get some idea as to how accurate or inaccurate they were.

Obviously, a good deal of experience was necessary before the surgeons could achieve any degree of accuracy. I still don't know exactly how accurate they are, but I have reason to believe that they are in a position to indicate with fair accuracy the degree of enlargement of the right ventricle and of the left ventricle. They can tell us very little about the right atrium, of course.

Correlation with autopsy findings is necessary before we can finally evaluate roentgen or surgical estimations of cardiac chamber size.

We are continuing to pursue this problem, correlating roentgenological and surgical data with the findings on the infrequent autopsy reports.

Vol. 71, No. 4

INFRAPULMONARY PLEURAL EFFUSIONS*

By ROBERT L. FRIEDMAN, M.D.
COLUMBUS, OHIO

A HIGH diaphragm, with or without other evidence of abnormality in the lung parenchyma, is a frequent finding in roentgen examination of the chest. With proper study, this is sometimes identified as infrapulmonary pleural effusion simulating a high diaphragm. This report deals with 17 such cases* collected in a relatively short time.

Rothstein and Landis[16] consider infrapulmonary pleural effusion simulating a high diaphragm an infrequent occurrence and report 12 cases. The earliest, if not the first report on this subject was made by Rigler[12] in 1931 in which he reported 2 cases. Since then, there have been nine papers[1,4,5,8,10,16,17,20,21] reporting approximately 27 cases, two-thirds of these in the last five years. Alertness to the possibility of fluid in this location, and careful roentgenological examination to prove its presence will result in the diagnosis being made more frequently.

The diagnosis of infrapulmonary fluid simulating a high diaphragm lies in determining the position of the collection of pleural fluid and its relationship to the diaphragm. The demonstration of small amounts of unencapsulated pleural fluid requires special methods. Ganter[2] showed that 400 cc. of fluid in the chest could not be determined by physical examination, and might not be visible in the erect teleroentgenogram. Rigler[13,15] agreed with this, but showed that with positioning of the patient in the lateral recumbent position, as little as 100 cc. of fluid could be demonstrated. In the supine and Trendelenburg positions, pleural fluid gravitated towards the apices and the position of the diaphragm could be visualized. Martin,[9] in 1925, described pneumoperitoneum as a means of demonstrating the undersurface of the diaphragm as the air-filled lung above delineates the superior surface. Pneumoperitoneum has been most useful in detecting infrapulmonary fluid simulating a high diaphragm on the right side. Insufflating the stomach with citrocarbonate, Seidlitz powders, or introducing air through a Levin tube will accomplish the same purpose on the left side by creating a large gastric bubble. Six of the 17 cases collected will be reported in detail to demonstrate the value of these various roentgenologic methods in diagnosing an infrapulmonary pleural effusion simulating a high diaphragm, and reveal some of the problems encountered.

* Six of the cases are from the Brooklyn Jewish Hospital (Dr. Milton G. Wasch, Director of the Department of Radiology) and 11 cases are from the McGuire Veterans Hospital (Dr. Samuel Richman, Chief of the Department of Radiology).

CASE REPORTS

CASE 1. B. H., a sixty year old white female attending the Radiation Therapy Clinic was admitted to the hospital with ascites. Eight months prior, a biopsy of a left supraclavicular node showed metastatic carcinoma. The left supraclavicular area was given roentgen treatment.

A roentgenogram of the chest (Fig. 1*A*) taken a few days prior to admission was reported as: infiltration in the right upper lobe, a left pleural effusion, and a high right diaphragm, probably due to ascites.

An abdominal paracentesis was performed and 3,500 cc. of pale amber fluid removed. A left thoracentesis yielded 1,100 cc. After the chest tap, a roentgenogram (Fig. 1*B*) revealed the following: "The infiltration in right upper lobe is unchanged. There is an infiltration noted in the left lower lung field, probably due to metastasis. There is marked diminution in pleural effusion on the left. Air is visualized under the right diaphragm probably a result of

* From the Department of Radiology, McGuire Veterans Administration Hospital, Richmond, Virginia. Published with permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the author.

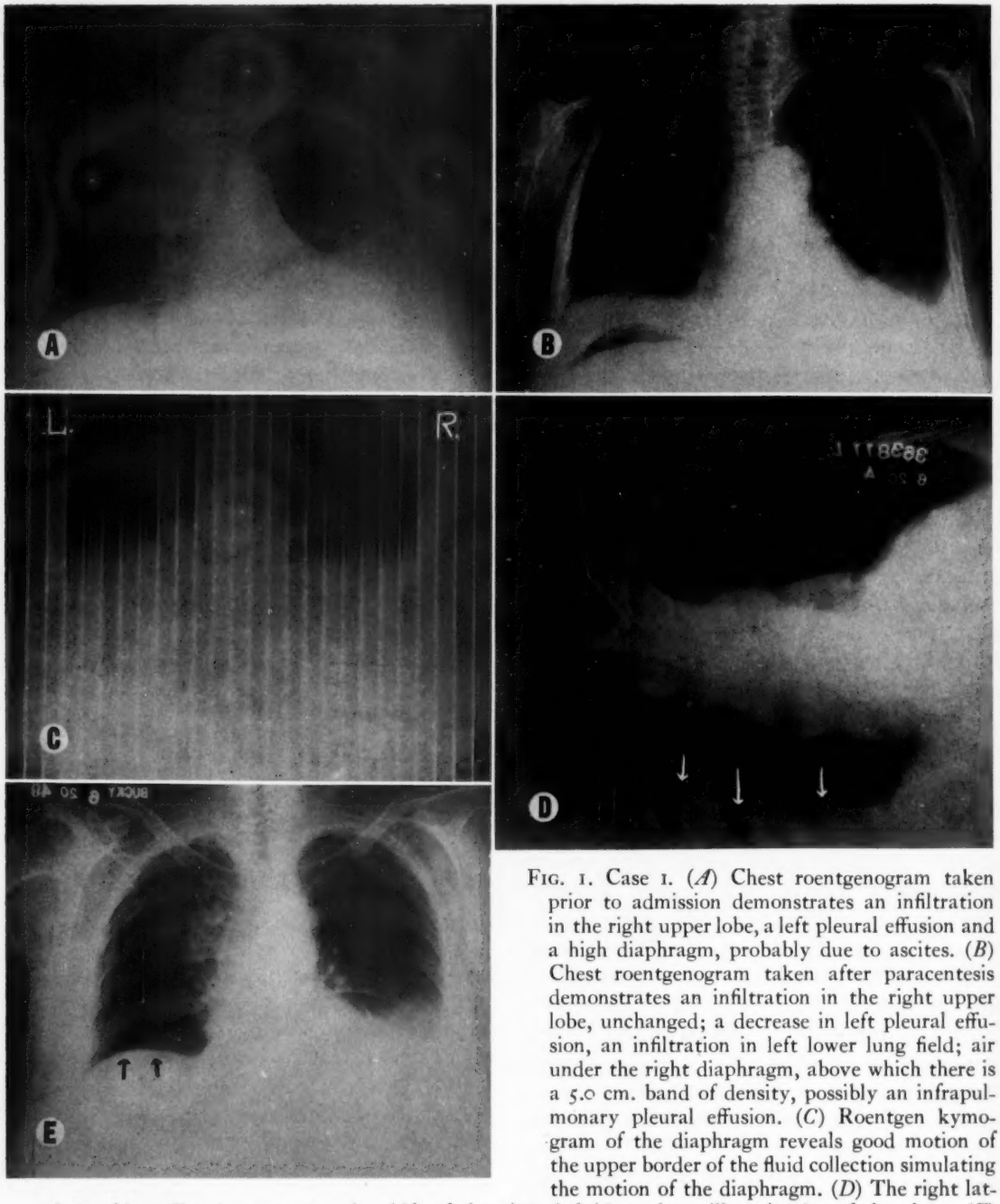


Fig. 1. Case 1. (*A*) Chest roentgenogram taken prior to admission demonstrates an infiltration in the right upper lobe, a left pleural effusion and a high diaphragm, probably due to ascites. (*B*) Chest roentgenogram taken after paracentesis demonstrates an infiltration in the right upper lobe, unchanged; a decrease in left pleural effusion, an infiltration in left lower lung field; air under the right diaphragm, above which there is a 5.0 cm. band of density, possibly an infrapulmonary pleural effusion. (*C*) Roentgen kymogram of the diaphragm reveals good motion of the upper border of the fluid collection simulating the motion of the diaphragm. (*D*) The right lateral decubitus film demonstrates the shift of the pleural fluid to the axillary border of the chest. (*E*) Roentgenogram of the chest, after a right thoracentesis removed 650 cc. of fluid, demonstrates the lower position of the right diaphragm and its thickness of approximately 0.5 cm. outlined by the air remaining beneath the diaphram in the peritoneal cavity.

the previous paracentesis. Above the gas, there is a 5.0 cm. dense band that has the contour of the diaphragm on its upper and lower margins. This is probably an infrapulmonary pleural effusion and further roentgen studies are advised." A roentgen kymogram (Fig. 1*C*) of the diaphragm revealed good motion of the upper border of the fluid collection simulating that of a diaphragm. A right lateral recumbent film (Fig. 1*D*) demonstrated a shift of the fluid to the axillary border of the chest and the diaphragm was noted in its lower, more normal, position.

A right thoracentesis was done and 650 cc. of fluid obtained. Re-examination of the chest (Fig. 1E) revealed a minimal amount of air under the right diaphragm which was now a 0.5 cm. band of density (as compared to the previous 5.0 cm. band), and it was noted to be normal in position.

Comment. On the chest roentgenogram taken as an out-patient, an elevated right diaphragm could be logically explained by the increased intra-abdominal pressure secondary to ascites. Had a chest film not been taken after abdominal paracentesis, the infrapulmonary collection would have gone unnoticed.

This case demonstrates the value of pneumoperitoneum in outlining the undersurface of the diaphragm. With air above and below the diaphragm, its shadow is sharply defined, and any increase in its thickness or depth is readily noted. Further studies can then be done to determine the cause of this increase in thickness, which in this case was proved to be free infrapulmonary fluid by the decubitus film. Further confirmation was obtained by the removal of 650 cc. of fluid and the post-thoracentesis roentgen study demonstrating the normal diaphragmatic shadow.

Case II. C. H., a colored female, aged thirty-six, was readmitted to the hospital for removal of ascitic and pleural fluid. The latter was noted on the out-patient roentgenogram (Fig. 2*A*). She had been discharged three months previously after laparotomy for inoperable carcinoma, primary site undetermined. Following discharge from the hospital, she had received radiation to the pelvis.

The right pleural cavity was tapped and 1,500 cc. of fluid obtained. An abdominal paracentesis was performed, 2,600 cc. of fluid removed, and partially replaced by air. A roentgenogram of the chest (Fig. 2*B*) revealed a decrease in the right pleural effusion, and the thickness of the left diaphragm appeared greater than normal. The left pleural cavity was then needled and 10 cc. of fluid was obtained. Another roentgenogram showed no appreciable difference in the thickness of the left diaphragm.

The patient was roentgenographed (Fig. 2*C*) one month later. The left diaphragm appeared elevated. A Seidlitz powder was given and on the roentgenogram (Fig. 2*D*) the distended stomach bubble outlined the undersurface of the diaphragm. A 7.0 cm. wide dense band separated the lung from the stomach bubble. A left lateral recumbent film (Fig. 2*E*) visualized fluid along the rib margin. Following a left thoracentesis yielding 700 cc. of fluid, the diaphragm appeared normal in thickness and position.

Comment. This case demonstrates the value of increasing the size of the stomach bubble so that the undersurface of the diaphragm can be visualized.

Case III. S. S., a female, aged fifty-three, was admitted with fever and pain in the right chest of one week's duration, made worse by deep inspiration and cough. There was a history of asthmatic attacks daily for the last nine months.

The chest roentgenogram revealed a pleural effusion on the right. This was tapped twice and, after the second tap, tumor cells were reported in the Papanicolaou and cell block studies.

A later chest roentgenogram showed the right lung field to be clear, except for slight elevation of the left diaphragm. Only on the lateral recumbent views (Fig. 3*A*) of the chest was fluid noted in the left pleural cavity. After pneumoperitoneum (Fig. 3, *B* and *C*) the left diaphragm was demonstrated to be broader than the right. A left thoracentesis obtained 175 cc. of fluid.

Comment. This case represents the usual finding of elevation of the diaphragm with no obvious fluid in the erect position. Special views (lateral recumbent, supine, or Trendelenburg) are required to make the diagnosis.

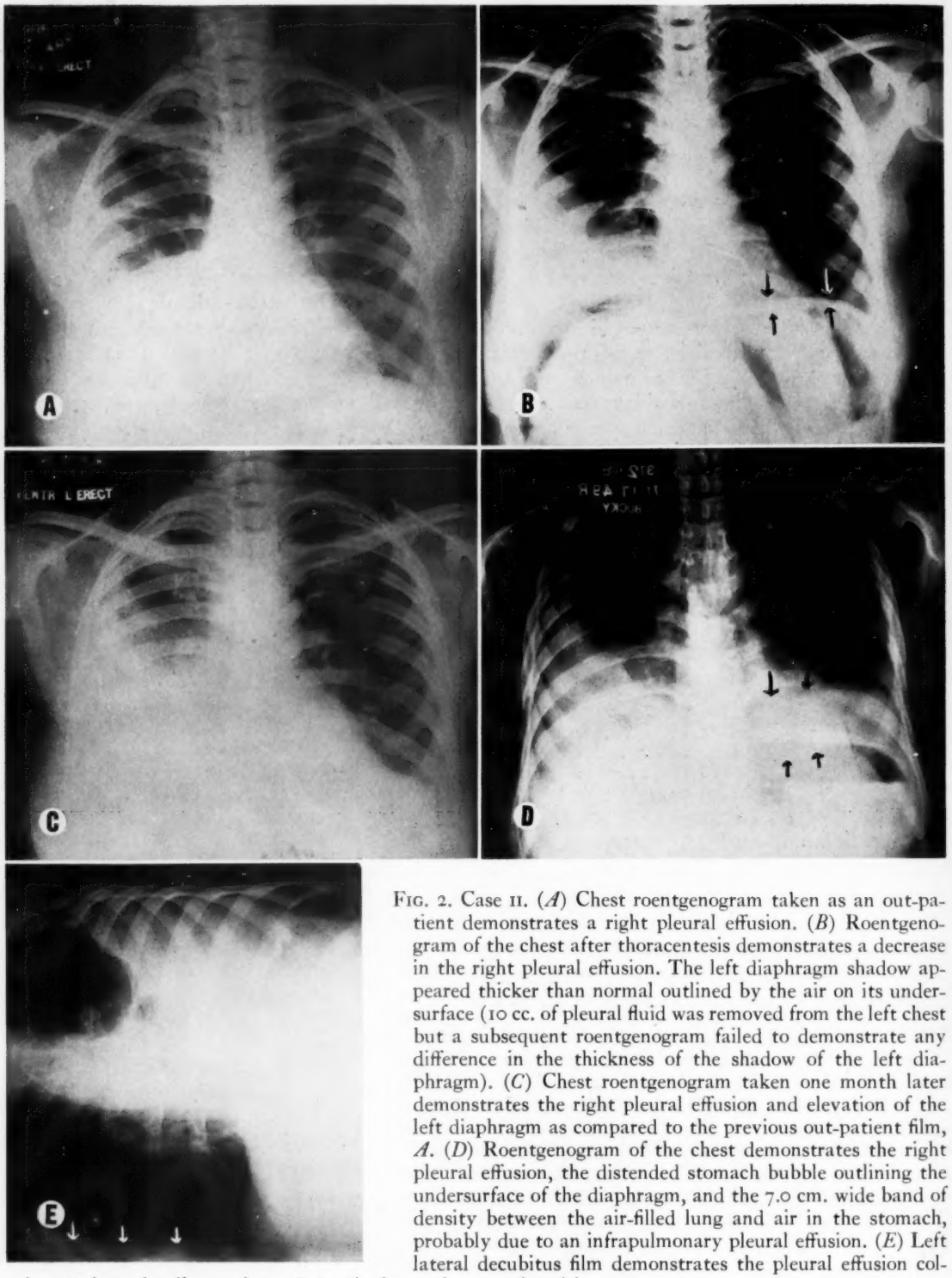


Fig. 2. Case 11. (*A*) Chest roentgenogram taken as an out-patient demonstrates a right pleural effusion. (*B*) Roentgenogram of the chest after thoracentesis demonstrates a decrease in the right pleural effusion. The left diaphragm shadow appeared thicker than normal outlined by the air on its undersurface (10 cc. of pleural fluid was removed from the left chest but a subsequent roentgenogram failed to demonstrate any difference in the thickness of the shadow of the left diaphragm). (*C*) Chest roentgenogram taken one month later demonstrates the right pleural effusion and elevation of the left diaphragm as compared to the previous out-patient film, *A*. (*D*) Roentgenogram of the chest demonstrates the right pleural effusion, the distended stomach bubble outlining the undersurface of the diaphragm, and the 7.0 cm. wide band of density between the air-filled lung and air in the stomach, probably due to an infrapulmonary pleural effusion. (*E*) Left lateral decubitus film demonstrates the pleural effusion collected along the rib margin, and the diaphragm in normal position.

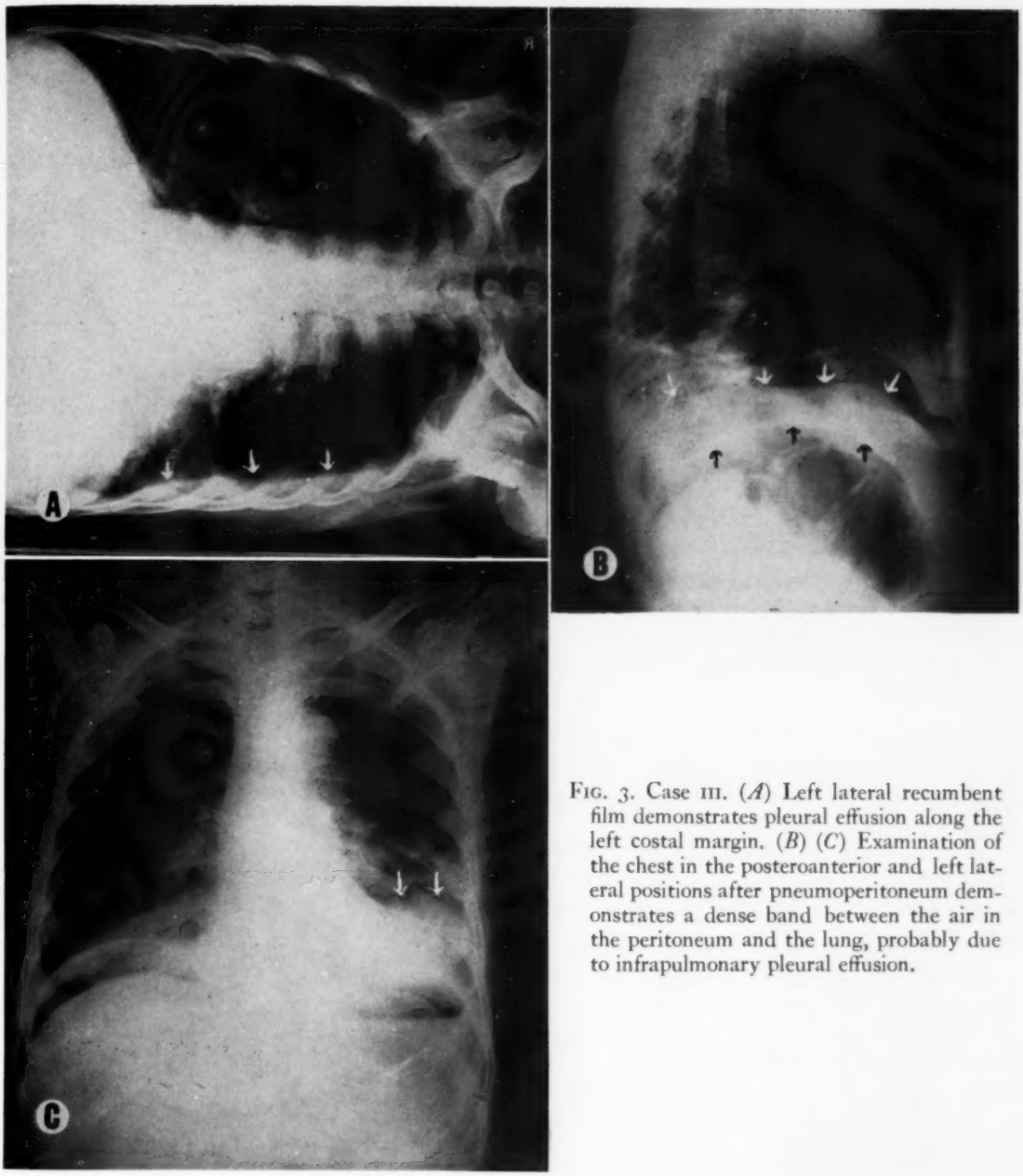


Fig. 3. Case III. (*A*) Left lateral recumbent film demonstrates pleural effusion along the left costal margin. (*B*) (*C*) Examination of the chest in the posteroanterior and left lateral positions after pneumoperitoneum demonstrates a dense band between the air in the peritoneum and the lung, probably due to infrapulmonary pleural effusion.

Case IV. M. F. P., a white male, aged fifty-six, was admitted with carcinoma of the lung with metastasis to the right cervical lymph nodes proved by biopsy. Three courses of nitrogen mustard and roentgen therapy were given with symptomatic relief. The patient died four months later.

Three weeks before death, a chest roentgenogram (Fig. 4*A*) showed extensive infiltrations on both sides radiating laterally and superiorly from the hilar regions. There was a homogeneous density overlying the right lower lung field, with a curvilinear upper margin at the fourth anterior rib which was assumed to be the diaphragm. A small amount of fluid was suspected on the right side but the diaphragmatic elevation was believed to be due to phrenic paralysis.

A roentgenogram of the ribs in the supine position (Fig. 4*B*) failed to reveal any bony metastasis. The diaphragm in this view was at a

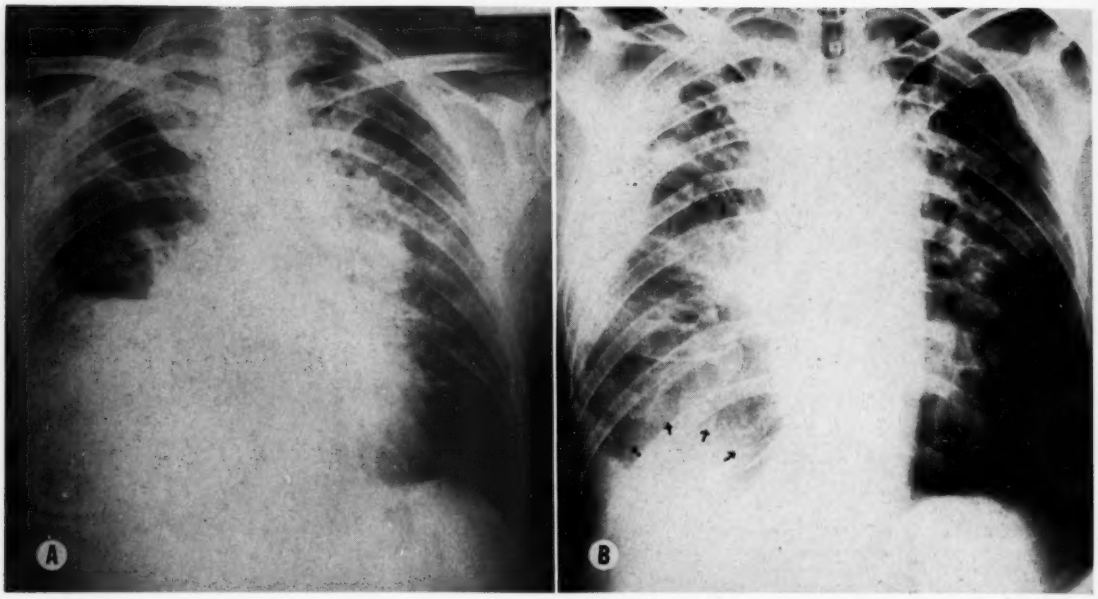


Fig. 4. Case iv. (*A*) Roentgenogram of the chest reveals infiltration of both lung fields radiating from the hili, and the homogeneous density overlying the right lower lung field with the curvilinear upper margin at the level of the fourth anterior rib which was assumed to be the diaphragm. (*B*) Supine view of the chest reveals the collection of pleural fluid at the costal margin and apex of the chest and the diaphragm is in normal position.

lower level and the fluid was seen at the periphery of the chest and at the apex. In spite of these findings, the diagnosis of infrapulmonary effusion was made only after autopsy.

At postmortem, 1,500 cc, of amber-colored, rapidly clotting free fluid was found in the right chest. The right diaphragm was at the same level as the left diaphragm.

Case v. W. J. G., a colored male, aged thirty-five, was admitted with the diagnosis of nephrotic syndrome, cause undetermined, and the patient was discharged, improved, six weeks later.

The original chest roentgenogram (Fig. 5, *A* and *B*) was reported as showing blunting of the left costophrenic angle with the left leaf of the diaphragm obscured.

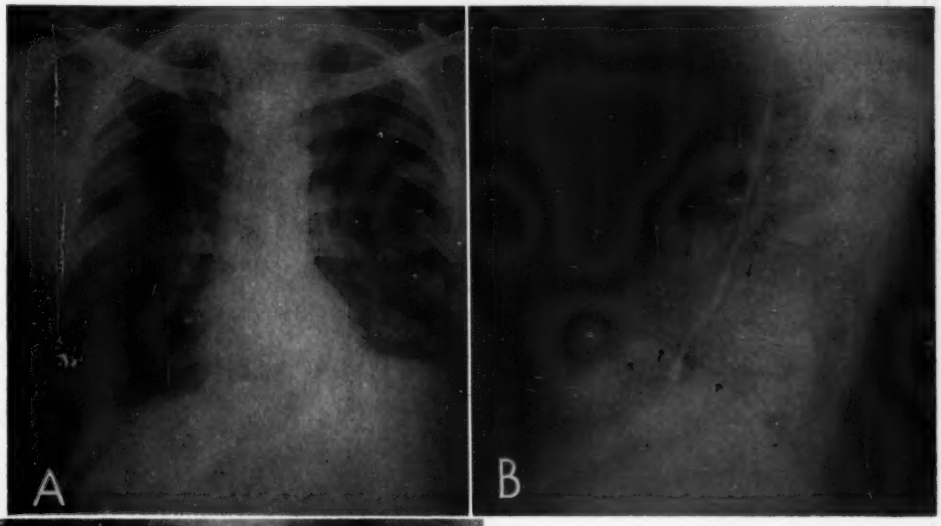
Roentgenoscopically, in the erect position, a density was seen occupying the left lower lung area. This area of density moved with respiration and, as outlined from below by the gastric bubble, measured approximately 5.0 cm. in thickness. In the supine position (Fig. 5*C*) the density became less distinct and the diaphragm was noted to be in normal position. These findings suggested an infrapulmonary pleural effusion.

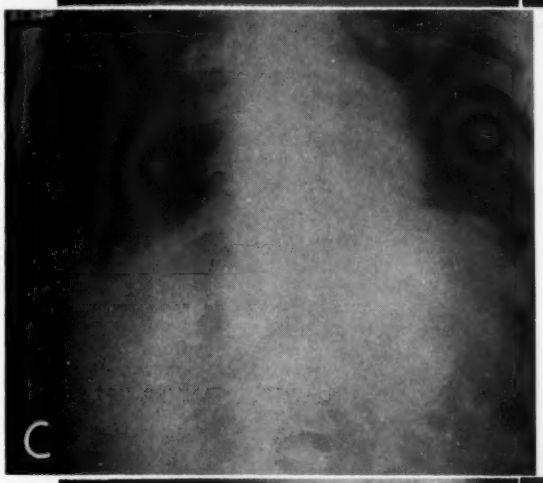
A left thoracentesis obtained 700 cc. of fluid and follow-up roentgenograms (Fig. 5, *D* and *E*) showed a disappearance of the density previously noted.

Case vi. H. C., a white male, aged twenty-two, was readmitted with a swollen face and distended abdomen. He had been discharged two weeks previously, after prolonged hospitalization for chronic glomerulonephritis, nephrotic stage.

The discharge and readmission roentgenograms were similar. There was a veiling of the left mid-lung field due to a loculated effusion or thickened pleura situated posteriorly. Re-examination (Fig. 6*A*) two weeks later showed no change except for a slight elevation of the right diaphragm. Because of a suspicion of a thickened diaphragm above the stomach bubble and the slight elevation of the right diaphragm, lateral recumbent views (Fig. 6*B*) were taken. These showed the thickened pleura in the left chest cavity and no fluid. In the right chest cavity, however, there was a moderate amount of free pleural effusion.

Comment. The location of the right-sided fluid could not be accurately determined





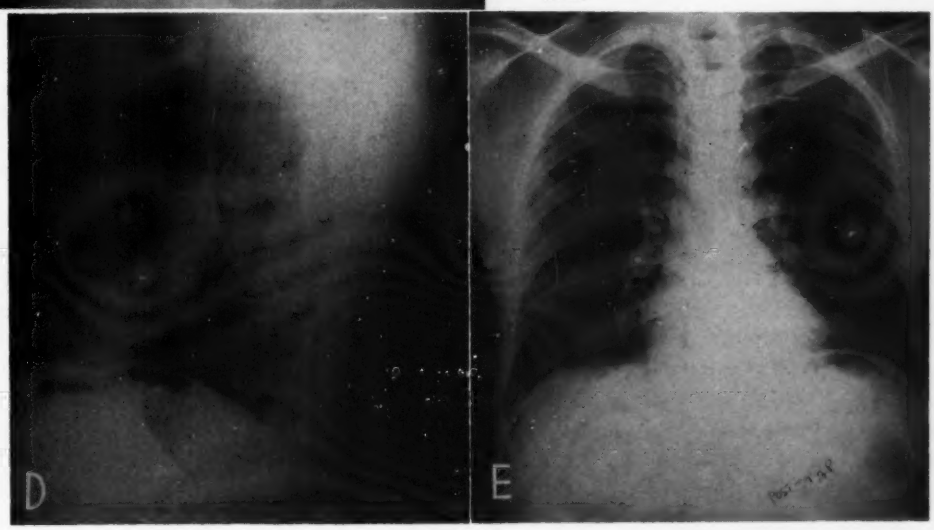


FIG. 5. Case v. (*A*) Roentgenogram of the chest reveals blunting of the left costophrenic sinus and obscuration of the left leaf of the diaphragm. (*B*) Left lateral roentgenogram of the chest demonstrates the 5.0 cm. band of density between the air in the stomach and air in the lung, probably due to infrapulmonary pleural effusion. (*C*) Supine view of the chest reveals the diaphragm in normal position and the density of the pleural fluid is not visualized. Examination of the chest in the posteroanterior (*E*) and left lateral (*D*) positions after removal of 700 cc. of pleural fluid reveals the diaphragm to be of normal thickness as outlined by gas in the stomach and the diaphragm in normal position.

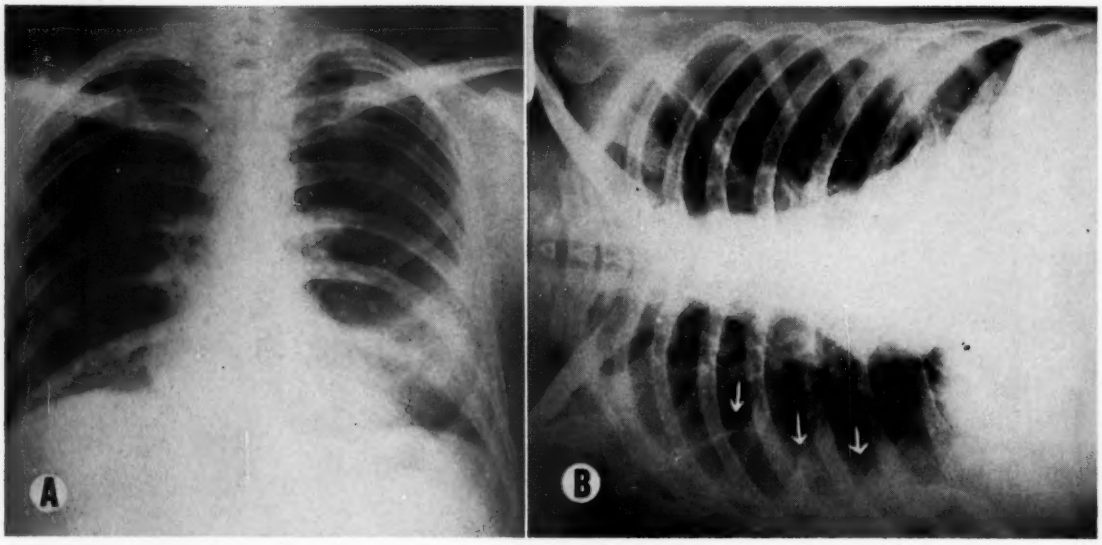


Fig. 6. Case vi. (*A*) Roentgen examination of the chest reveals veiling of the left lung field due to loculated effusion or thickened pleura, and no pleural effusion is visualized. The right diaphragm appears slightly elevated. (*B*) Right lateral recumbent film demonstrates fluid along the right costal margin.

since pneumoperitoneum and thoracentesis could not be performed. The slight elevation of the right diaphragm, however, was considered suspicious.

The necessity for the pneumoperitoneum is clearly shown in this case where the question of the location of the fluid, *i.e.*, posterior costophrenic sulcus or infrapulmonary, can only be differentiated by air under the diaphragm or inflation of the stomach, if the left side is in question.

Discussion

According to Rabin:[11] "The presence of clear limpid fluid in the free pleural cavity is evidenced roentgenologically by the presence of a dense shadow in the lower portion of the chest, which completely hides the boundary of the diaphragm. If the effusion is small, this shadow is seen to be present only in the costophrenic sinus, but if it is larger, it occupies the entire lower portion of the pulmonary field, is most dense at the base, and becomes gradually fainter in its upper portion. Usually the fluid extends higher in the axillary region than anywhere else." These remarks are similar to those of Rubin[18] and Sante.[19] The reason why free pleural effusion in certain instances collects between the lung and the diaphragm instead of in the usual distribution has not been determined.

The diseases in which infrapulmonary effusion occurs do not indicate the reason for this configuration. Lipschultz[8] stated that in his experience this atypical distribution had been most often seen in heart disease. He thought that the repeated decompensations producing fibrosis of the lung altered pulmonary retractility and might be the cause of infrapulmonary effusion, but this explanation is not valid for other cases unless the disease process which causes the effusion also affects the lungs. This report deals with: 5 cases of carcinoma, 3 cases of heart disease, 2 cases each of nephrosis, cirrhosis and 1 case each of leukemia, nephritis, postpneumonic effusion, postoperative effusion, and pleural effusion secondary to stab wound of the left subphrenic region. No evidence can be derived from these to substantiate Lipschultz' explanation.

The concept, that as pleural effusion occurs it gravitates to the posterior and lateral costophrenic sinuses, is generally accepted. On the basis of the present and previously reported cases of infrapulmo-

nary effusion, and on consideration of the works of Kaunitz[6,7] and of Rigler,[14] the author believes that the concept is incomplete. The former demonstrated by the injection of gomenol and lipiodol, substances lighter than pleural fluid, that a film of fluid exists in the pleural cavity above the level of the fluid visualized on the roentgenogram. This demonstrated to what height capillary pressure could draw fluid since it was believed that the nonvisualized film was the result of capillary force. Rigler, in studying the shift of pleural fluid by placing the patient in the recumbent position, makes the following statement: "There is one further effect resulting from this change of position which may be of considerable value in differentiating pleural fluid from thickening. In a number of cases, x-rays made with the patient in the recumbent positions have shown clearly the shadows of fluid in the interlobar fissures, although in the upright position no sign of the fissures can be made out. It appears to be due to a shifting of a small amount of fluid into the neighborhood of the interlobar fissure, into which it is drawn. This is chiefly due, no doubt, to the high degree of capillary pressure exerted by the small space which is there present." He goes on to give an explanation for the formation of encapsulated interlobar effusions on the basis of capillarity drawing fluid into the interlobar space which is then sealed off from the remainder of the pleural cavity.

The pleural space between the lung and the diaphragm is normally a potential space. When fluid gravitates to the costophrenic sinuses, capillary action could draw fluid between the lung and the diaphragm. The following sequence of events is suggested. When a small amount of fluid is formed, it gravitates to the posterior and lateral costophrenic sulci. The capillary attraction of the visceral and parietal diaphragmatic pleura then draws the fluid into this space. The majority of effusions thus are infrapulmonary in their beginnings. As more fluid accumulates, the minority maintain the configuration of infrapulmonary fluid, but the majority spill over, as it were, and assume the outlines of pleural effusion most commonly seen and described as typical.

The proof for this theory of formation of infrapulmonary fluid and the factors responsible could not be obtained from these cases. Case II, in the early stages when 10 cc. was removed and no difference in the thickness of the diaphragm shadow was noted, might have been of value if the effort was persisted in and more fluid had been withdrawn. Likewise, Case VI and the 11 cases, details of which have been omitted to avoid repetition, might have strengthened the theory offered had the patients been well enough to withstand thoracentesis. More cases, studied to completion, may produce the proof for the theory presented.

At the time this paper was in the final stages of preparation, Hessén's[3] monograph on the "Roentgen Examination of Pleural Fluid" came to hand. The author reviewed the literature exhaustively, and included five European papers containing 16 additional cases that were not available to me.

His clinical report was based on 9 cases without parenchymal changes, or significant pleural adhesions. The composition of the pleural fluid varied widely and Hessén felt that this variation indicated its lack of importance in determining the localization of free pleural fluid.

By a series of experiments consisting of injecting fluid into the pleural cavity of corpses and rabbits, it was found that where insignificant adhesions of the pleural cavity were present, infrapulmonary pleural effusion resulted, whereas, in the presence of pleural adhesions either in the corpse studies or in the experimentally induced adhesions in the rabbits, fluid collected typically. Hessén concluded that "If the unobstructed pleural space contains an effusion, the fluid will tend to obey the law of gravity. The lung on the whole retains its shape and floats on the fluid. If the patient is examined only in

frontal projection and upright position, the image will give the impression that the fluid is situated between the lung and the diaphragm. Thus, that which in the literature is called a 'paradoxical' or 'atypical infrapulmonary' localization of pleural fluid is simply its mode and distribution in free pleura, and the so-called 'typical pleural effusion' in the literature is caused by adhesions between the pleural membranes." Hence, Hessén's clinical and experimental work tends to confirm the author's theory that most pleural effusions are infrapulmonary in their beginnings but he goes further in his conclusion in stating that pleural adhesions are the determining factor in the localization of pleural effusion. The cases herein reported were not considered from this point of view. However, in Case IV, the only one in this collection examined at postmortem, no pleural adhesions were found.

Whenever the suspicion of fluid is aroused by a raised diaphragm or clinical course of the patient indicates the presence of fluid, the following should be done: (1) recumbent films to determine the presence of minimal pleural effusions; (2) pneumoperitoneum or distention of the stomach to outline the under surface of the diaphragms; (3) careful thoracentesis, and (4) re-examination roentgenographically to determine the decrease in thickness of the diaphragm and fluid shadow. Consideration of the possibility of infrapulmonary pleural effusion will result in more frequent diagnosis of the condition. Rothstein and Landis[16] aptly stated, "In the diagnosis of infrapulmonary effusions undoubtedly the most important feature is a high index of suspicion."

SUMMARY

1. Seventeen cases of infrapulmonary pleural effusion simulating an elevated diaphragm are reported.

2. A theory is offered for the development of pleural effusion to account for the roentgenographic picture seen in infrapulmonary pleural effusion and in effusions with the usual configuration.

3. Methods for confirming the diagnosis of infrapulmonary pleural effusion are presented.

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The author is indebted to Mr. J. Billups, Medical Illustration Department, McGuire Veterans Hospital, for the excellent photographic prints.

ADDENDUM

Since this paper was submitted for publication, a minimum of 20 additional cases of infrapulmonary pleural effusion have been diagnosed.

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RELIABILITY OF BRAIN TUMOR LOCALIZATION BY ROENTGEN METHODS*

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WITH the advent of pneumography, introduced by Dandy[3] in 1918, great forward strides have been made in the localization of intracranial tumors by various highly technical procedures. Pneumatization accomplished by means of direct ventricular puncture was shortly followed by the replacement of fluid with gas by way of the spinal canal, the procedure being known as pneumoencephalography.[4] In 1927 Egas Moniz[5] of Lisbon injected cerebral vessels by way of the carotid with strontium bromide to render them opaque to roentgen rays, and by 1940 the procedure of cerebral angiography was beginning to be used in clinical practice in this country. In 1929 electrical currents generated in brain substance detected and recorded by way of skin surface electrodes were employed by Berger[2] to produce the electroencephalograms in man. Results of the employment of this procedure were appearing with fair frequency in American literature by 1941. The employment of radioactive diiodofluorescein in the diagnosis and localization of brain tumors was described by Moore[8] in early 1948. Today this procedure is being used in several clinical centers.

Together with roentgen examination of the unprepared skull, these relatively new diagnostic methods have enormously increased the ability of physicians to determine the location of brain tumors within the intact skull as compared with localization achieved on the basis of observed neurological signs. In early communications[6,7] the effectiveness of roentgenological methods of brain tumor localization as employed at the University Hospital (Ann Arbor) was analyzed and reported for the first three years and the remaining seven years of the decade July 1, 1931 to June 30, 1941. The total number of authenticated brain tumors included in those reports was 565. In the succeeding decade, July 1, 1941 to June 30, 1951, 755 additional authenticated brain tumors were subjected to some form of preoperative roentgenological examination. An analysis of the efficacy of those procedures in this new patient group is herewith presented.

SELECTION OF MATERIAL

Selection of clinical material for the present analysis consisted of including all examples of brain tumors which conformed to the following criteria:

1. Established diagnosis of brain tumor recorded during the ten year period July 1, 1941–June 30, 1951.
2. Known tumor site as determined by craniotomy or autopsy.
3. Established identity of tumor on the basis of histopathologic examination.
4. Recorded results of some form of roentgen examination of the skull or brain.

Among 1,029 brain tumor patients originally contacted during the established time interval, 755 conformed to the above stipulations. Whenever any of the four criteria could not be met, that patient was excluded. With the aid of mechanical sorting equipment all records were critically reviewed to determine the histopathological identity of the tumor, its proved location—whether by operation or autopsy, localization data on the basis of neurological examination, electroencephalography, routine roentgen examination of the skull, air encephalography, cerebral angiography and ventriculography. In addition, the registration number, sex and age were recorded for each patient. The raw data, too

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extensive for publication in the JOURNAL, will appear as an appendix in reprints for the benefit of any who wish to make further use of the source material.

The tumors in this group, arranged according to Bailey's classification of brain tumors,[1] are listed for purposes of reference in Table I separately and in combination with previously reported material for the immediately preceding decade.

ACCURACY OF INDIVIDUAL METHODS OF EXAMINATION

From the tabulated information derived from original patient records, it was readily possible to determine with what accuracy tumor localization had been achieved by each of the specialized examination methods in comparison with the actually determined site of the tumor. In scoring accuracy, it was necessary to employ discretion in judging whether, for example, "temporoparietal" reported on the basis of some particular examination could be called correct when at operation the tumor site was described as "temporal." In arriving at decisions of this sort it was held that statements regarding localization which were sufficiently specific to lead the surgeon to make an opening in the skull through which the tumor could be encountered must be considered accurate for all practical purposes. Many situations in which routine skull examination was able to show the presence of a lesion in one or the other cerebral hemisphere without more specific localization were scored as errors.

Not all of the special procedures were used in every case. The frequency with which various roentgenological methods were employed, together with the percentage of accuracy scored by each, is shown in Table II. The previously reported figures for the preceding decade are included although cerebral angiography was not employed in the earlier series. The progressive decrease in the accuracy of routine skull localization is explained by the more rigid scoring methods employed in the final ten years. It will be noted that encephalog-

TABLE I

1,320 BRAIN TUMORS CLASSIFIED ACCORDING TO BAILEY[1]

	1st Decade	2nd Decade	Total
Encephalic Tumors			
Gliomas			
Glioma unclassified	23	33	56
Glioblastoma multiforme	102	215	317
Spongioblastoma polare	21	21	42
Ependymoma	22	16	38
Neuroepithelioma	0	0	0
Astroblastoma	7	16	23
Astrocytoma	119	115	234
Oligodendroglioma	30	30	60
Glioneuromas			
Medulloblastoma	37	52	89
Ganglioneuroma	0	3	3
Tumors of Covering Cells (Nervous System)			
Meningeal tumors			
Meningothelioma	68	129	197
Fibroblastoma	2	0	2
Osteoma	1	1	2
Lipoma	0	1	1
Melanoblastoma	2	0	2
Sarcoma	16	22	38
Sheath tumors			
Neurinoma	35	55	90
Hypophyseal Tumors			
Adenomas			
Undifferentiated	4	1	5
Basophile	1	0	1
Eosinophile	0	0	0
Chromophobe	24	45	69
Craniopharyngiomas	22	17	39
Dysembryomas			
Teratoid cyst	3	1	4
Pearly tumor	4	8	12
Chordoma	1	3	4
Pinealoma	10	5	15
Papilloma	3	0	3
Vascular Tumors			
Hemangioblastoma (Lindau's type)	8	14	22
Angioma racemosum	0	0	0
Capillary telangiectasis	0	0	0
	565	803	1,368

TABLE II

	Three Years 190 Tumors		Ten Years 565 Tumors		Twenty Years 1,368 Tumors	
	Times used	Accuracy	Times used	Accuracy	Times used	Accuracy
Routine skull roentgenogram	167	30%	527	24%	1,307	22.5%
Air encephalogram	21	76%	48	69%	86	65 %
Cerebral angiogram	—	—	—	—	178	72 %
Ventriculogram	70	91%	282	92%	732	88 %

raphy and ventriculography have changed but little in percentage accuracy over the entire period of time. Cerebral angiography in comparison with the aerographic methods is obviously a reliable procedure.

DETERMINATION OF THE ACTUAL UTILITY OF VARIOUS DIAGNOSTIC DEVICES

Throughout the entire twenty year period it is observed that detailed neurological examination has scored well in its own right as a means of determining the location of intracranial tumors. On the basis of the current ten year analysis it was accurate in 60.5 per cent of all cases. Since this method of examination presents no hazard to the patient, its usefulness should, of course, be exploited to the fullest.

An analysis of the actual utility of various roentgen diagnostic methods among the 190 patients considered in the first of the previous reports[6] (Chart 1) demon-

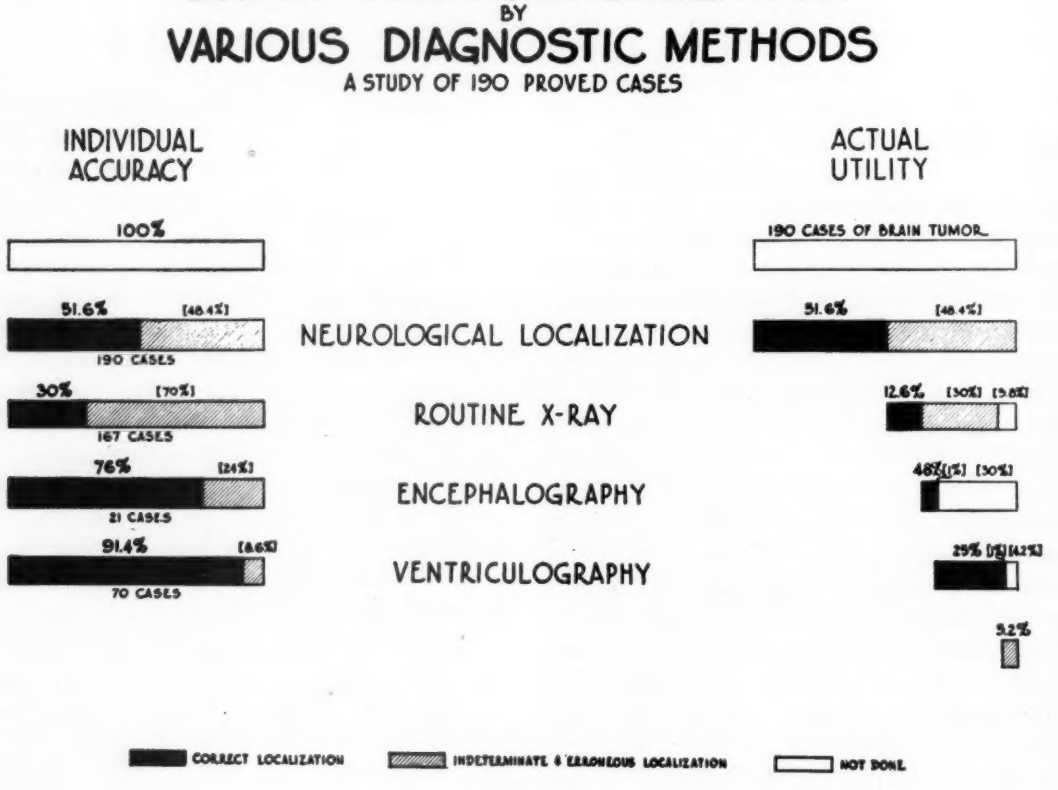

CHART I

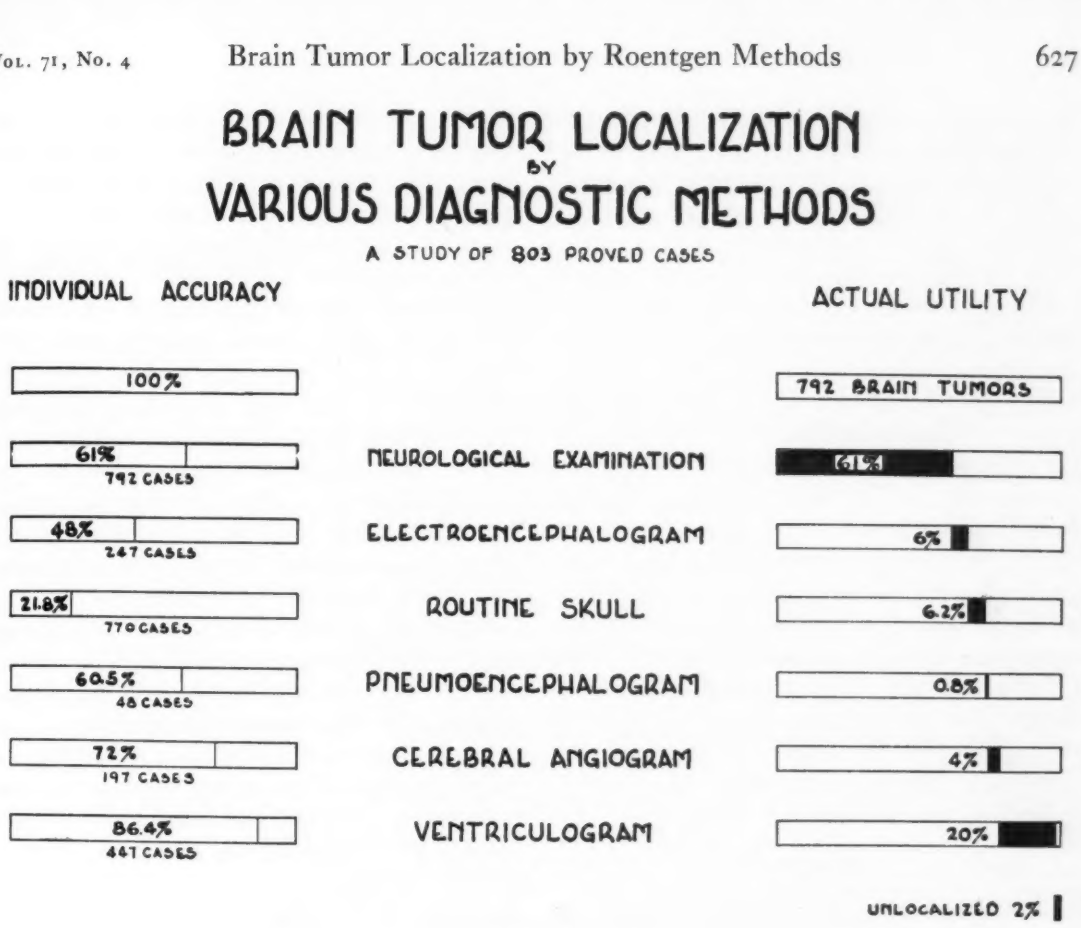

Chart II

strates how routine skull examination was employed to further increase the accuracy of localization among patients who failed to present localizing neurological signs. The residue of unlocalized tumors was still further narrowed by the employment of encephalography within this group. The results of ventriculography, among patients whose tumors had not been localized by other means, reduced the residue to 5.2 per cent. It will be noted that high individual accuracy, as determined on the basis of all material so examined, dwindles in terms of percentage when that method is evaluated only after simpler, less traumatizing procedures have been tried without success or have provided erroneous impressions.

The current material, when treated in this same fashion, produces a similar pattern and records an almost identical overall end accomplishment (Chart II). This time, in addition to neurological examination, the technical procedures of electroencephalography, routine skull examination, pneumoencephalography, cerebral angiography and ventriculography, arranged in this order of increasing disturbance and hazard to the patient, have been scored and recorded. During the ten years under consideration the effectiveness of neurological methods of examination has been measurably greater than in the preceding decade. This is not a difficult finding to explain. Although the sizable group of clinicians in various fields has changed materially over the years, continuous and concerted diagnostic effort toward more and more accurate preoperative localization has left its mark. Accumulated experience sharpened by successes with all of the methods has become apparent.

Electroencephalography, employed in something over one-fourth of the cases in the present series, has been helpful but not

in a phenomenal way and the same is true for routine skull examination where actual utility has suffered from stringent scoring rules. In terms of actual utility pneumoencephalography appears to have contributed little, although it is to be remembered that its employment was greatly restricted. Cerebral angiography appears on the basis of this analysis to have contributed only moderately to over-all accuracy of tumor localization and yet, as in the case of pneumoencephalography, in certain types of intracranial tumor its usefulness was spectacularly great. As on the earlier occasion, ventriculography, when credited with success only when some or all of the other methods failed, provided information leading to the actual site of the lesion in all but a very small residue of patients. This residue is to a considerable extent irreducible because it contains several instances where localization was determined only at the time of autopsy.

DISCUSSION

The addition of electroencephalography and cerebral angiography to somewhat older methods of brain tumor localization which have performed so well in the past has not materially altered the already highly efficient preoperative localization of intracranial neoplasms. This must not be construed to mean that the relatively recently introduced methods are devoid of virtue for that certainly is untrue. Put to the rigid test of utilitarian worth, electroencephalography, which presents no added hazard to the patient, measurably extends the efficacy of standard neurologic procedures.

Routine examination of the skull, so easily and innocuously employed, will fail more often than not to give any sign whatever to indicate the presence of intracranial tumor. Only once in five times, when tumor is known to be present, can the actual location of the lesion be determined by this method. However, in the case of oligodendroglioma, by virtue of visible calcification within the tumor in many instances, skull filming accurately localized this type of tumor 14 times in 30 tries, while in chromophobe adenoma of the pituitary it was accurate 31 times in 43 examinations, and in craniopharyngioma 14 times in 17.

Pneumoencephalography, which is subject to stringent restrictions in many examples of brain tumor, can be used very effectively in the case of tumors involving the brain surface, especially at the base, where other methods are apt to falter. Despite controversial restrictions in its application to large groups of tumors of all types and localities, the importance of this tool is not to be overlooked.

Cerebral angiography is another procedure which has specific fields of usefulness. Arterial visualization resulting from opaque injection of the carotid system cannot be expected to provide much in the way of helpful information in the case of tumors located in the posterior fossa, or for that matter in the basal ganglia. In the case of meningothelioma, on the other hand, our data prove that this method of approach provided accurate localizing information 37 times in 40 trials, and in glioblastoma multiforme 56 times in 79 trials.

Ventriculography, the best of the specialized methods both in point of individual accuracy and actual utility, is widely useful, scoring heavily in the very posterior fossa tumors in which cerebral angiography is of little value. Used in 45 of 52 medulloblastomas, ventriculography correctly localized 43 tumors.

With the best interests of the tumor patient in mind, it is obvious that there must be great overlapping of the various specialized methods of intracranial examination. The approach to the over-all diagnostic procedure should be well considered and should not be carried beyond the reasonable limits of practicality.

CONCLUSIONS

1. Among the various methods for determining the actual location of intra-

cranial tumors before craniotomy, detailed neurologic examination is the most highly utilitarian.

2. Subjected to practical testing in direct comparison with other specialized methods of tumor localization, electroencephalography proves itself to be valuable and deserves particular consideration because of the fact that it is nontraumatizing to the patient.

3. Roentgenological skull survey without previous preparation is capable in its own right of localizing with dramatic accuracy the location and sometimes the character and size of certain intracranial tumors. Because of the simplicity of this procedure and the convincing evidence which it sometimes produces, this method deserves wide application.

4. Pneumoencephalography should be employed in preference to other methods when there is reason to expect that this procedure is apt to be more successful than others. Under these circumstances it may be expected by the radiologist that he can compete in terms of localizing accuracy with carefully conducted neurological examination.

5. Cerebral angiography is a most illuminating procedure in many examples of brain tumor. If there is reason to suspect that the tumor lies in the posterior fossa it should not be used. It is considered to be less traumatizing to the patient than ventriculography and, therefore, when proper facilities for its employment are available it deserves to be widely used.

6. Ventriculography, which often must be followed promptly by craniotomy because of the sometimes dramatic effects of altered hydrodynamics within the cranial vault, should yield accurate localizing signs nine times out of ten when applied to a patient group containing tumors of all sorts within the skull. This degree of accuracy, of course, depends upon the ability and experience of the investigators, but a traumatizing and measurably hazardous procedure of this sort can scarcely be justified unless the examiner can score this heavily.

7. The entire matter of brain tumor localization has reached a high level of performance in the matter of accuracy of localization of tumor site. This degree of accuracy can be expected, however, only when the best efforts of a divergent group of clinical performers, including the radiologist, are brought to bear in concerted fashion on the individual problem in hand.

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DISCUSSION

Dr. Harold O. Peterson, St. Paul, Minn. There are two points in a study of this type that occur to me as being important. In the first place, Dr. Hodges and Dr. Holt must have learned a great deal personally about brain tumors while reviewing all of these cases, and consequently the University of Michigan must be a good place to go if one has a brain tumor.

Secondly, it is important from time to time that someone analyze our results, to find out just how well we are doing with various diagnostic procedures. There are some difficulties, however, which occur to me in a study of this type, and I wonder how Dr. Hodges solved the

problems which I have had in our institution.

First, it must be very difficult to clearly and concisely catalog *every* case that you examine, from the standpoint of the accuracy of either the clinical diagnosis or the roentgen diagnosis, in order to put it definitely in a positive or negative group. It seems to me there ought to be an indeterminate group. I have a number of cases that are indeterminate in my work, and the clinicians have such cases, too. When I look over the clinical charts they do not always have one final diagnosis but rather many possibilities.

In the next place, the rigid requirements which Dr. Hodges used in selecting these cases of necessity eliminate a large group of patients who have been examined but not proved. There may be many errors, clinically as well as roentgenologically in this group. They may go elsewhere and the tumor be discovered, or die from their disease, or recover from an incorrectly diagnosed lesion, and as far as the local statistics are concerned, they are not included. It means that part of our error is lost sight of in these statistics.

It would be interesting to study a complete group of patients—every patient, who came into the department finding out what ultimately happened to every one of those cases, and then you would have a true figure as to the percentage of error in diagnosis.

Therefore, I would say we should not relax with the impression that we are now able to recognize 97 per cent of brain tumors by using all of these methods. Actually, this 97 per cent means that, of the patients who have proved tumors either by operation or autopsy, 97 per cent were localized, but the patients who were not so proved, histopathologically, although they have been completely studied and completely examined may still have a tumor and we do not know how many we are missing.

In the accuracy of the plain film diagnosis that Dr. Hodges showed, I noted it has dropped from 50 to 20 per cent in the last ten year period. I would like to suggest a possible explanation for that drop, which we have experienced in our institution also. I believe that patients are being studied earlier in the course of their disease than they were formerly. They are coming in for diagnosis before they have developed the classical roentgen changes and so we are unable to make a diagnosis.

In spite of the use of angiography, electroencephalography, radioactive materials and sharper clinical analysts, I am surprised to see that 449 of the last 755 cases (which is 60 per cent) still had ventriculograms. This brings up the point that if the neurological examination is 60 per cent accurate there should be only 302 cases left for ventriculography, which is only 40 per cent of the total cases.

But 449 were still examined by ventriculography, which means that a good many of the neurologic diagnoses, even though later proved correct, were not good enough at the time they were made to actually warrant a craniotomy. The clinician usually says he knows the diagnosis and that all he needs the x-ray for is confirmation. However, these figures would suggest that when it comes to opening the skull, the neurosurgeon greatly appreciates a preoperative roentgen localization.

For this reason I object to the chart which gives the actual utility of clinical diagnosis as 60 per cent, and the total utility of the roentgen ray as only 30 per cent including all of its applications. I think it is actually much higher from a practical standpoint, especially in the estimation of neurosurgeons.

I should like to close with three questions: I wonder if Dr. Hodges uses angiography for histologic diagnosis to the extent that patients who are diagnosed angiographically as having a glioblastoma are not operated upon as is advocated in some of the Scandinavian countries.

Second, do you intentionally use encephalography on brain tumor suspects, or were the 38 cases, on whom encephalograms were employed, done somewhat accidentally, expecting some other diagnosis?

Third, there were 75 pituitary tumors which were not shown in the presentation today. Of these 75 pituitary tumors there were no eosinophilic adenomas. Does this mean that all the eosinophilic adenomas are treated and cured by roentgen ray so that there was no histologic material available?

I have enjoyed reading this paper and greatly appreciate the work entailed in obtaining these statistics covering such a long time interval. We are indebted to Dr. Hodges and Dr. Holt for establishing a new set of standards for the accuracy of roentgen diagnosis of brain tumors.

Dr. Hodges (closing). I am very appreciative of Dr. Peterson's remarks, which are very pertinent and to the point.

He asked how one acquired definitive in-

formation about clinical material over such a long period of time. I simply point out the fact that in our institution, using IBM punch card equipment, we have been recording all diagnoses since 1934, and since 1936 all cancer material has been specifically handled in this fashion. In our record room if a hospital record is selected at random and one fails to find a brilliant canary yellow set of sheets at the top it is known at once that one is not dealing with a case of neoplasm within the agreed reportable group.

To be sure there are some human errors and every once in a while one comes to light; but, by and large, the clerks in the record room will not record nor accept for deposit a hospital record on which any diagnosis on the top sheet is one of the reportable neoplasms, unless the neoplasm data sheets have been filled in. Therefore, withdrawal of record material which concerns brain tumors is simply and quickly accomplished.

Furthermore, double checking is possible. In the case of all patients examined in the roentgen department diagnostic statements are recorded daily on roentgen department punch cards. By sorting all examples of encephalographic, ventriculographic or angiographic skull examinations the same patient material comes to light as well as the roentgen diagnosis.

Using these methods, we found that 1,026 brain tumors had been encountered in the last ten years, 755 of which conformed to the criteria established for inclusion. The remaining patients either were never proved histologically or were never subjected to roentgen examination of the skull. The material here reported has been certified to the best of our ability.

Dr. Peterson is entitled to assume that we may have made gross errors in localization among the 271 patients deleted from the group here reported. While I doubt that the factor of error was 100 per cent, the only fair way to deal with nonverified material is to delete it.

The advantages of roentgen examination, particularly ventriculography, over neurological examination is a point well taken by Dr. Peterson. I think that all of us in this room are well aware of those advantages. Time and again one is asked to do highly specialized and perhaps dangerous types of intracranial examination, sometimes when localization of a tumor has already been clearly established. Under such circumstances one might well ask, "Why go any further?" I am sure we have conducted many elaborate intracranial examinations for which there was no imperative need.

Dr. Peterson is quite right in saying that the neurological examination, although ultimately found to be correct, may not have impressed the neurosurgeon sufficiently to make him want to turn a bone flap, and we have been asked to provide more definitive information. Time and again we have done just that.

Dr. Peterson asked three questions: First, did we use cerebral angiography for histologic diagnosis? We have a place in our regular catalog that goes on punch cards for an opinion on the part of the radiologist as to the histopathologic nature of brain tumors which we encounter. Our batting average is not high, but it is true that certain types of tumors, as seen in roentgenographic terms, can sometimes allow one to make a very shrewd guess as to the histopathologic type. That is one reason for the rather extensive use of cerebral angiography at our hospital.

Second, do we use encephalography on tumor suspects broadly and widely, and what limits the use of this procedure? The utility figure for pneumoencephalography, 0.8 per cent, indicates its limited use by us. We try to use it when tumors on the brain surface or at the base of the brain are suspected.

In the case of the 75 pituitary tumors, Dr. Peterson has hit the nail on the head. There must be more pituitary tumors than those reported in a brain tumor group of the size we have reviewed. He asked the specific question as to whether all eosinophilic tumors in the pituitary were treated by roentgen ray, and therefore were not subject to autopsy. Both Dr. Holt and I were amazed to find that not a single eosinophilic pituitary tumor was included in this list. We went back and checked on them individually and found that, as a matter of fact, they had been treated radiologically and were not subjected to craniotomy.

There were also some basophilic adenomas which were not subjected to proof prior to autopsy.

Since the reading of this paper, 48 additional examples of proved acoustic tumors have been discovered which had been confusingly listed in the diagnostic record index. These have been incorporated into Table I and Chart II.

AN UNUSUAL FORM OF FIBROUS DYSPLASIA OF BONE

REPORT OF THREE CASES*

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FIBROUS dysplasia is a disturbance of development, the cause of which is unknown. It is seldom seen in infancy but develops during childhood, the lesions sometimes growing slowly until adult life has been reached, at which time growth of these lesions is usually arrested. The roentgenologic diagnosis of solitary lesions of fibrous dysplasia of bone is sometimes difficult, and it is not infrequent that the diagnosis can be made with certainty only by means of biopsy. When fibrous dysplasia of bone is polyostotic in character, the lesions have a somewhat characteristic appearance, and as a rule the roentgenologic diagnosis can be made with ease.

Fig. 1. Typical fibrous dysplasia with lesions affecting primarily the marrow and spongiosa of the bone, with thinning of the overlying cortex and expansion of the affected segments of bone.

The characteristic lesions of polyostotic fibrous dysplasia have been described many times[2,3,7,8] and will be discussed here only for the purpose of comparing these with the unusual lesions of fibrous dysplasia that are the subject of this paper. Fibrous dysplasia is often limited to one side of the body, but when there is extensive skeletal involvement the lesions are usually bilaterally located, with most of the lesions on one side. The lesions are well circumscribed and the unaffected bone appears perfectly normal. In the usual cases, the involved bone shows replacement of the medullary structure by fibrous tissue which leads to thinning of the cortex of the overlying bone and in many cases there is moderate or extreme expansion of the involved bone (Fig. 1). As a result of this type of involvement, the affected bone often appears abnormally radiolucent and roentgenologically the affected bone may appear cystlike, whereas pathologically these are not cystic lesions but are composed of masses of fibrous tissue. Localized areas of osteosclerosis are frequently found in these radiolucent lesions and in some cases the osteosclerosis is quite conspicuous.

The pathologic picture in this type of fibrous dysplasia is quite distinctive, the spongiosa and marrow of the affected bone being replaced by fibrous tissue, among which are found spicules of degenerating and regenerating bone. Islets of cartilage are observed not infrequently. That fibrous dysplasia is a defect in endochondral bone formation is shown by the fact that bones that are involved are often abnormally short.

The purpose of this paper is to present

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Fig. 2. Case 1. The right femur is abnormally short and at the upper and lower ends of the shaft it can be seen that the lesions have developed subperiosteally.

data on 3 cases of fibrous dysplasia, the roentgenologic appearance of which is quite different from that seen in the usual cases of fibrous dysplasia. These 3 cases will be discussed in some detail, and pathologic material will be described to support the thesis that the skeletal lesions in these cases are manifestations of an unusual form of fibrous dysplasia of bone.

REPORT OF CASES

Case 1.* A white girl, three years of age, was first seen at the Mayo Clinic on July 23, 1928, the complaint being that there was a lump on the right leg and that there had been difficulty in walking for one year. Her birth and early development had been normal, but when she was twelve months of age her parents noted that the right leg was shorter than the left. At the age of eighteen months, when the patient began to walk, a limp of the right leg was evident. Shortly thereafter, a small lump was noted in the midportion of the right thigh. Since birth, there had been an area of discoloration on the back of the head, and this area had always been devoid of hair.

Physical examination at the time of admission revealed the right leg to be 1 6/10 inches shorter than the left. Some atrophy of the right leg was also present and mild genu valgum was apparent. There was a moderate degree of left thoracolumbar scoliosis, which was considered compensatory in nature. A large area of alopecia was present in the occipital region of the scalp, and the skin of this region was pigmented. The results of examination of the thorax were negative, except for a loud systolic murmur

Fig. 3. Case 1. In this projection it seems apparent that the involvement of the midportion of the femoral shaft has also developed subperiosteally.

* Case previously reported by Dockerty, M. B., Ghormley, R. K., Kennedy, R. L. J., and Pugh, D. G. Albright's syndrome (polyostotic fibrous dysplasia with cutaneous pigmentation in both sexes and gonadal dysfunction in females). *Arch. Int. Med.*, 1945, *75*, 357–375.

Fig. 4. Case 1. There has been a pathologic fracture of the right tibia, with residual deformity. Subperiosteal involvement of the lower part of the right tibia and of both ends of the right fibula is conspicuous.

heard over the entire precordial region. This was thought to be attributable to a congenital cardiac defect that was not of a serious nature.

Results of laboratory examinations were negative. Roentgenograms of the right upper and lower extremities showed unique skeletal lesions. There was involvement also of the left radius and ulna. There appeared to have been a pathologic fracture involving the upper third of the right tibia (Fig. 2, 3, 4 and 5).

From 1928 to 1932, the patient was seen yearly at the Mayo Clinic. Roentgenologically, the osseous lesions appeared to progress somewhat in extent, although there was little disability. In 1932, on the basis of biopsy of the osseous lesion of the right tibia a diagnosis of "osteitis fibrosa with a few scattered foreign body giant cells" was made. In 1934, a pathologic fracture was sustained through the lesions involving the lower end of the right tibia and fibula. Fixation was accomplished by means of homogenous grafts. Roentgenograms at that time showed a pronounced involvement of the femur, ilium, tibia and fibula on the right, the right clavicle and the right scapula. The left radius and ulna were affected, as were the ninth and tenth thoracic vertebrae, pelvis, right innominate bone, the second right rib and the eleventh left rib. There was some involvement of the skull, which was asymmetric as a result of the right parietal bone being somewhat thicker than the left. At this time, it was found that the value for serum calcium was 9.7 mg., the serum phosphorus 6.0 mg., and the serum phosphatase 6.2 Bodansky units per 100 cc.

The patient was next seen at the Clinic in 1941. She had sustained a pathologic fracture of the right femur in 1937. Several attempts to secure proper fixation by means of open reduction had been unsuccessful. At this time, it was revealed that she had begun menstruating shortly after her twelfth birthday. Tissue that had been removed from the tibia in 1932 and during the procedure of bone grafting in 1934, was available for study, and upon review the pathologic diagnosis was "fibrous dysplasia with variable numbers of giant cells." The presence of giant cells can be attributed to the fact that pathologic fractures had taken place, and therefore these are considered to be foreign body giant cells. Some cartilage was present and

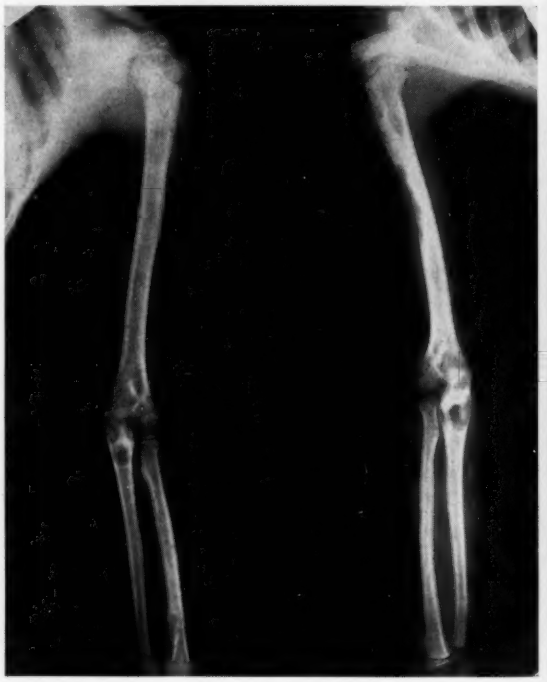

Fig. 5. Case 1. The bones of the right upper extremity are involved rather extensively but the left arm is also affected.

in both specimens fragments of bone were seen, as well as islands of osteoid surrounded by active osteoblasts.

In 1941, it was also noted that there were café au lait spots over the body, the pigmented areas no longer being limited to the scalp. At that time, it was observed that the patient's height measured 3 feet 2 inches at the age of three years; 4 feet at the age of six years and only 4 feet 5 inches at the age of fifteen years, which indicated that an early acceleration of growth had been arrested prematurely. The skeletal lesions and regions of pigmentation of the skin would suggest that this patient had Albright's syndrome, and although menstruation was not precocious the premature arrest of growth seemed to result from early somatic maturation. This is not unusual in cases of Albright's syndrome.

Case II. A white boy, nine years of age, was first seen at the Clinic on August 8, 1932, the complaint being that he had had bone trouble which was first found in February, 1932. His birth and development had been normal and nothing was noted until February, 1932, when his mother noticed a little swelling over the upper part of the left leg. There was no pain on walking but the swelling was very tender if bumped or pressed hard. He played and ran just as he had before, but seemed to be a little bit lame.

Fig. 6. Case II. The lesions in the distal ends of the left tibia and fibula are obviously subperiosteally located. It appears that there has been a pathologic fracture of the upper third of the left tibia which has healed without deformity.

Fig. 7. Case II. The left femur is abnormally short and the lesion in the distal third has developed subperiosteally. Near the greater trochanter there is a cystic appearing lesion which would probably be shown to be a subperiosteal defect if a tangential, rather than a frontal, projection had been taken.

The results of physical examination at the Clinic were essentially negative. He was 53 inches in height and his weight was 67 pounds. A small, hard nodular swelling could be felt at the junction of the middle and upper third of the left tibia. This was tender to deep palpation.

Roentgenograms revealed lesions of the left first metacarpal, the upper and lower portions of the left femur, the left tibia, fibula and astragalus. There appeared to have been a pathologic fracture of the upper third of the left tibia (Fig. 6 and 7).

Fig. 8. Case III. In the frontal projection the lesions appear to be centrally localized, but in the tangential view it seems obvious that the lesions developed subperiosteally. This roentgenogram was taken on January 4, 1945.

One determination of the serum calcium was 11.2 mg. per 100 cc. The validity of this determination is questioned. The level of the serum phosphorus was 3.5 mg. per 100 cc. The serum protein was 7.22 mg., and the serum alkaline phosphatase was 17.1 and 14.1 units per 100 cc. by the Bodansky method.

One year later August 11, 1933, biopsy material was removed from the lower end of the left tibia. The surgeon reported that a curet was pushed through the cortex, which was thin and easily broken off. The pathologic diagnosis at that time was foreign body giant cell tumor tissue. Review of this tissue has revealed that the pathologic process in the tissue was fibrous dysplasia with a number of foreign body giant cells present. There is no evidence, however, that this was a giant cell tumor.

A letter of inquiry sent out on January 21, 1936, revealed that the patient had had no further trouble with the skeletal lesions, had had no symptoms, nor had there been any pathologic fractures.

Case III. A white girl, seven years of age, was admitted to the Clinic on July 12, 1944. Her health appeared to have been good until seven days before admission, when she fell on the sidewalk, fracturing her left femur. At the time of the fracture, the pain was not especially great, but she could not walk without limping and there was considerable pain if she attempted to raise the leg. Previous to the fracture, she had never complained of pain in the left leg.

Upon admission to the Clinic, physical examination revealed that she had a fracture of the lower part of the left femur. An extensive birthmark was observed over the left arm and the left side of the neck, thorax and abdomen.

Roentgenologic examination revealed that there was a pathologic fracture through a region of fibrous dysplasia in the left femur. Not only the left femur but also the tibia and fibula of that leg were involved (Fig. 8 and 9).

The results of laboratory examinations were essentially negative and the levels of the serum calcium, phosphorus and alkaline phosphatase were normal.

After the first admission, the girl was seen many times. On February 4, 1945, she fell and

Fig. 9. Case III. The lesion in the lower third of the left tibia is definitely subperiosteally located. This roentgenogram was taken on January 4, 1945.

FIG. 10. Case III. Roentgenogram taken on July 16, 1952, shows the lesion of the upper part of the tibia to be filling in with bone that looks fairly strong.

again fractured the left femur. On September 18, 1945, the lesion involved in the left femur was curetted and a bone graft was placed at the site of fracture. At the time of operation, the lesion of the bone showed a fairly firm shell around it, and the lesion consisted of a yellowish brown soft tissue. On the basis of biopsy a diagnosis was made at that time of "osteitis fibrosa, with many giant cells." The term "osteitis fibrosa" is somewhat equivocal, and review of this tissue has shown that this was fibrous dysplasia, with foreign body giant cells being present.

The girl was seen yearly from 1946 to 1951. It became apparent that the left leg, especially the left femur, was abnormally short, and by July, 1949, the left leg was $4\frac{1}{2}$ inches shorter than the right, but the bone appeared to be fairly firm and strong.

Roentgenologic examinations in 1952 revealed some evidence of healing of the skeletal lesions. The rather extensive lesions in the lower part of the left femur and upper part of the left tibia seemed to have filled in with fairly strong bone (Fig. 10 and 11).

The skeletal lesions and extensive café au lait spots are suggestive of Albright's syndrome but menstruation was not precocious, beginning normally at the age of fourteen years, and therefore the endocrine component of Albright's syndrome is lacking.

COMMENT

The roentgenologic appearance of the lesions of the bones in these 3 cases is quite different from that seen in the usual cases of fibrous dysplasia of bone. This is shown most clearly in Case 1, in which the patient had Albright's syndrome (Fig. 2, 3, 4 and 5). The skeletal lesions in this case all appear to have developed as a subperiosteal process, the involvement of the bone having

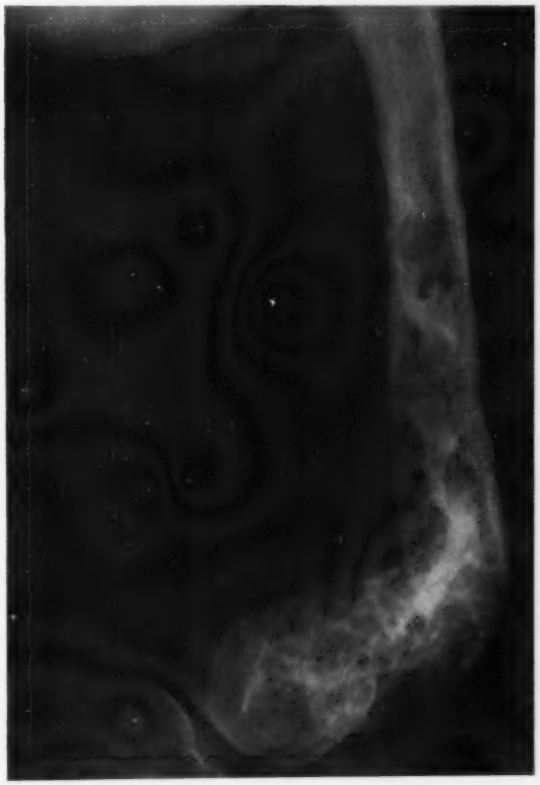

FIG. 11. Case III. Roentgenogram taken on July 16, 1952, shows marked deformity of the lower part of the femur, but the bone appears to be quite firm and strong.

Fig. 12. Case I. Tissue removed in 1934, showing fibrous dysplasia with islets of cartilage and foreign body giant cells. In other sections, spicules of bone were found in the fibrous tissue.

developed along the external aspect of the bones, with the medullary portions and spongiosa affected only secondarily. Although endochondral bone formation is not altered so severely in this case as it is in many cases of fibrous dysplasia, the right femur is shorter than the left, which would indicate that there has been disturbance of endochondral bone growth. In Case II, the lesions are not so conspicuously subperiosteal in location (Fig. 6 and 7). Tangential views of all the lesions are not available, but the lesions in the lower ends of the left tibia and fibula appear definitely to have developed subperiosteally, like those seen in Case I. The lesions in the left femur and upper part of the left tibia appear to be centrally located, but close observation shows that these also probably developed subperiosteally. The lesion of the upper part of the left tibia is distorted, as the result of a pathologic fracture. In Case III, some of the lesions appear to be centrally located and have a cystlike appearance, but close observation again shows that these lesions also probably developed as subperiosteal processes and that the cystlike appearance is the result of observing the lesions in a frontal view instead of in a tangential projection (Fig. 8 and 9).

Pathologic examination of the tissue obtained in these 3 cases revealed that in each instance the lesion was fibrous dysplasia, without question. In all of these cases there was present an unusually great number of giant cells, but it seems most likely that these are foreign body giant cells, and there is no pathologic evidence that these lesions are a variety of giant cell tumor. It seems likely that the foreign body giant cells that are present in these cases are there as a reaction to the pathologic fractures that had occurred. None of the tissue in these cases showed

Fig. 13. Case II. Tissue removed in 1933. The lesion consists mostly of fibrous tissue, with very little bone or cartilage present. Foreign body giant cells are fairly numerous.

any pathologic evidence suggesting neurofibromatosis. In Case I, there was very extensive replacement of the bone by fibrous tissue. Cartilage and spicules of degenerated and regenerated bone were also found. The pathologic picture is typical of fibrous dysplasia (Fig. 12). In Case II, the pathologic picture consisted mostly of replacement of the bone by fibrous tissue, without much evidence of cartilage or bone formation, at least at the site of the biopsy (Fig. 13). In Case III, numerous foreign body giant cells were especially conspicuous, but otherwise the pathologic picture was that usually encountered in fibrous dysplasia (Fig. 14).

One cannot help being impressed by the close resemblance between these unusual skeletal lesions of fibrous dysplasia and those that occur in the type of chondrodysplasia known as Ollier's disease. It seems that in the one condition there is a fibrous dysplasia of bone and in the other a cartilaginous dysplasia of bone, but in each condition the bone is affected in a similar place and in somewhat a similar manner.

FIG. 14. Case III. Tissue removed in 1945. There are a great number of foreign body giant cells in the fibrous tissue.

FIG. 15. Ollier's chondrodysplasia. At the growing ends of the diaphyses there are longitudinal bands of cartilage that lie subperiosteally, to a great extent. At the metaphyses there are masses of cartilage which prevent remodeling and which often contain punctate deposits of calcium.

Both Ollier's disease and fibrous dysplasia tend to be predominantly unilateral in distribution. Both conditions may cause retardation of endochondral bone growth. These 3 unusual cases of fibrous dysplasia show subperiosteal defects in the bone that are quite similar to those seen in Ollier's disease (Fig. 15 and 16). That the metaphyses of the bones are affected less in this type of fibrous dysplasia than in Ollier's disease would suggest that the defect in these cases of fibrous dysplasia occurs in a later stage of development than it does in Ollier's disease.

The pathologic picture of Ollier's disease consists of foci of hyaline cartilage with signs of degeneration or calcification, which are seen as longitudinal stripe-shaped,

sharply limited clear areas in the diaphysis of the bone, especially at the ends of the bones. The metaphyseal portions of the bones are often made up of masses of cartilage. Langenskiöld[5,6] has given an excellent description of the pathogenesis of the lesions of Ollier's disease. He has observed

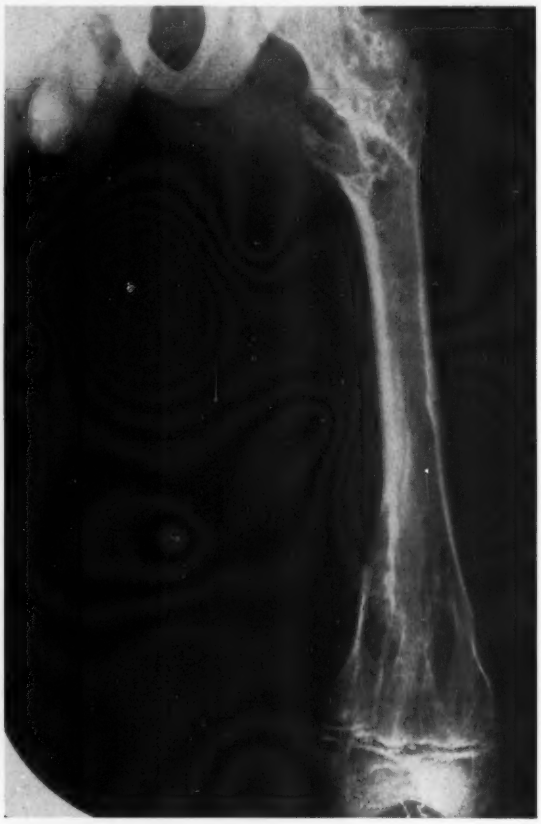

Fig. 16. Ollier's chondrodysplasia. The subperiosteal location of some of the cartilaginous masses is evident.

that in Ollier's disease not only are lesions found which appear to be subperiosteal in location, but also it is not uncommon to see marked disturbance of the metaphysis or growing end of the bone. Thus, the primary disturbance in Ollier's disease seems to be in the cartilage plate of the epiphyseal line. Langenskiöld quoted Ranvier as concluding that the osteogenic layer of the periosteum of the normal growing bone probably originates in cells primarily lying within the epiphyseal cartilage. Certain undifferentiated cells of the epiphyseal cartilage gradually migrate to the periphery, to form eventually the osteogenic layer of the periosteum. Langenskiöld has shown that the cartilaginous lesions of Ollier's disease progress in a similar way, from the central portion of the epiphyseal cartilage and the metaphysis to the periphery of the bone, to lie eventually in a subperiosteal location along the diaphysis. It seems that a similar and analogous process takes place in certain cases of fibrous dysplasia, and this explains the peculiar location and appearance of the fibrous dysplasia that has occurred in these 3 cases under discussion.

That these lesions of fibrous dysplasia are not Ollier's disease is shown by the biopsies which showed no evidence of the pathologic appearance of Ollier's disease. Ollier's disease is not accompanied by cutaneous pigmentation as were all 3 of these cases. Precocious somatic development is not a part of Ollier's disease. It is therefore inconceivable that the first patient, who had Albright's syndrome, has had Ollier's disease. It might also be mentioned that whereas calcification is seen frequently in the cartilaginous lesions of Ollier's disease, no such calcification was seen in these subperiosteal lesions of fibrous dysplasia.

There are those who might suggest that these cases of fibrous dysplasia are actually manifestations of neurofibromatosis. There is no evidence in these cases to support that concept, nor incidentally is there good evidence to support the broad concept that neurofibromatosis and fibrous dysplasia are closely related or identical conditions.[1,4] None of the pathologic material that was examined showed any evidence of neurofibromatosis. Neurofibromatosis is frequently accompanied by cutaneous pigmentation, but it differs somewhat from the café au lait spots of fibrous dysplasia. In rare instances, some endocrine disturbance may accompany neurofibromatosis, but Albright's syndrome does not occur in neurofibromatosis. Definite pathologic fractures occurred in 2 of these cases, but in neither instance was the appearance in any

way similar to the pseudoarthroses that are seen accompanying neurofibromatosis.

CONCLUSIONS

1. Three cases with an unusual form of fibrous dysplasia of the bone have been presented.

2. These patients had skeletal lesions that appeared to develop subperiosteally and affect the spongiosa and marrow only secondarily.

3. In all three cases, regions of pigmentation of the skin, so-called café au lait spots, were present.

4. One patient had skeletal lesions, cutaneous pigmentation and precocious somatic development and was considered to have Albright's syndrome.

5. Pathologic examinations showed the skeletal lesions in these three cases to be fibrous dysplasia.

6. Roentgenologically the skeletal lesions in these cases resemble to a certain extent those seen in Ollier's disease, and the development of the two conditions appears to be somewhat analogous.

7. This form of fibrous dysplasia of bone can be distinguished roentgenologically from Ollier's disease and neurofibromatosis.

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DISCUSSION

Dr. Ralph S. Bromer, Bryn Mawr, Pennsylvania. Dr. Pugh has shown us 3 cases which illustrate that fibrous dysplasia like other dystrophies of bone does not always show typical roentgenographic changes. I agree with him that his cases show a resemblance to Ollier's disease and I agree with him that a differential diagnosis can be made.

It might be well to review the clinical development of Ollier's disease. It usually is shown by limping as one of the first symptoms. There may be shortening which is discovered at birth or shortly afterward. The further course is characterized by increase in the shortening and by bending and thickening of the ends of the tubular bones during growth, and this growth disturbance seems to be related to the degree of the development of the foci in the metaphyses. If the foci are large, lateral foci will cause a valgus deformity and medial foci will cause a varus deformity. These deformities are different in appearance from those shown in Dr. Pugh's cases.

Schlumberger, in his review of 60 or more cases of fibrous dysplasia, pointed out that some lesions may develop subperiosteally. In his cases, the subperiosteal development was usually located in the metaphyses and submetaphyseal areas, but in several cases was found in the midportion of the shaft. The midportion is rarely affected in Ollier's disease, and usually the involvement extends downward or upward in the long bones to the epiphyseal plate. In Dr. Pugh's cases some of the lesions did not show such extension.

I cannot feel as certain as Dr. Pugh that the

diagnosis of multiple neurofibromatosis can be readily excluded. Dr. Holt, some years ago, showed that this condition can simulate many other bone lesions. I wish to ask Dr. Pugh if he used the Bodian stain in the histological sections to demonstrate nonmedullated nerve fibers, as recommended by McNairy, and Montgomery and Schlumberger, the absence of which would tend to exclude neurofibromatosis in difficult cases.

When I read Dr. Pugh's paper I was intrigued by the large birthmark present in his first case and immediately turned to the illustrations of the bone lesions. Multiple hemangiomas occur in connection with multiple enchondromas in what is known as Marfucci's syndrome. There is of course no question of this diagnosis in his cases.

I think the point made by Dr. Pugh that his cases illustrate the occurrence in fibrous dysplasia of subperiosteal lesions in the metaphyseal areas as well as elsewhere in the shaft is a most useful diagnostic point which in the future will be helpful in the differential diagnosis of fibrous dysplasia.

Dr. Pugh (closing). I appreciate some of the points that Dr. Bromer has brought out; I believe they are important.

Frankly, I must admit that we have not used special stains in these cases to rule out neurofibromatosis. The tissue we did study showed no evidence that we could see of neurofibromatosis. The presence of cartilage in these lesions and the spicules of bone and osteoid found seemed to me to be rather overwhelming evidence against neurofibromatosis. It is true that along with the lesions of neurofibromatosis that show nerve elements, there are other areas where there is just tissue dysplasia without the typical appearance that you expect to see in neurofibromatosis. Neurofibromatosis has many manifestations but I think that these cases did not have neurofibromatosis.

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OSTEITIS CONDENSANS ILII*

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and
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OSTEITIS condensans ilii is primarily a roentgenologic diagnosis based on the appearance of dense sclerosis involving only the iliac side of the sacroiliac joint. The sacroiliac joints are clear with normal bony architecture visualized in the sacrum. The area of bone condensation is usually fairly well circumscribed; it may be unilateral or bilateral, and is usually seen in the inferior two-thirds of the ilium. The condition is said to occur almost exclusively in women.[5] Shipp and Haggart[7] state that in their experience (100 cases) this condition occurs only in the female.

The finding of 8 males with this condition in a series of 20 cases during the past year prompts us to report this group.

HISTORICAL

In 1926, Sicard, Gally and Haguenau[8] reported 5 cases and are accredited with the first article on this subject. Barsony and Polgár[1] described this condition in 1928 as a sclerosis in the iliac bone. In 1932, Berent[2] described the condition occurring as a result of pregnancy. Three cases are reported occurring with some injury before and during delivery. This author maintained that the condition had been seen by him only in women following delivery.

In 1936, Rendich and Shapiro[6] reported osteitis condensans ilii in 9 females and 3 males. It was this report that made it clear that the condition was not limited to females. The literature has since had several reports which were mostly limited to females.

Brailsford,[3] in 1924, described a rare type of sacroiliac arthritis in a forty year old female with low back pain. This he subsequently called osteitis condensans ilii, the roentgen reproduction being typical of this condition. He points out that it may be seen in long-standing damage to the contralateral hip joint when this process is unilateral.

Several of our cases are not in agreement with this finding. Admittedly the finding of osteitis is not common, and seeing this condition associated with pelvic fractures is probably less common. Case 6 is of interest in this respect since osteitis condensans ilii was noted on admission to the hospital for a subtrochanteric fracture of the right femur. The sclerosis of the ilium was bilateral and most marked on the side of the injury. A previous history of back pain was denied. Case 2 revealed sclerosis of the right iliac portion of the sacroiliac joint. This was noted in an examination to exclude a fracture of the right hip joint. This patient had been completely asymptomatic until this examination. A previous history of back complaints was denied. Case 7 also was noted to have right iliac sclerosis on admission for an acute fracture of the pelvis. Re-examination at six months revealed sclerosis still evident. No previous history was obtained.

CASE PRESENTATION

Table 1 gives a compilation of the cases found at this hospital in the past year. This group contains 8 males and 12 females.

ANALYSIS OF CASE MATERIAL

It is felt that the finding of 8 males with a condition that has in the past been ascribed mostly to females is unusual. Except for Case 3, all of the male group had no symptoms that could be attributed to osteitis condensans ilii. This finding in this series would suggest that patients having this condition have been incorrectly diag-

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TABLE I

COMPILATION OF CASES

Case Number	Age	Sex	History	Physical Findings	Roentgen Examination
1	22	M	Acute injury left hip. Denies previous back complaints	Pain in left hip on motion	Hip joints are normal. Bilateral sclerosis of the ilia
2	22	M	Acute injury to right hip. Denies previous back pain	Pain in right hip on motion	Well defined sclerosis of the right ilium
3	21	M	Low back pain, nonradiating, noted for the past several years	Negative	Sclerosis of both ilia
4	21	M	Epigastric pain. Denies previous back injury or complaints	Negative	Bilateral iliac sclerosis noted on a barium enema study
5	22	M	Trauma to thorax and back 3 months prior to examination. Past history denied	Negative	Bilateral sclerosis of the ilia
6	22	M	Automobile accident. Acute injury to right leg. Past history of back pain denied	Clinical fracture of the right femur	Subtrochanteric fracture of right femur. Bilateral iliac sclerosis most marked on right
7	24	M	Automobile accident. Acute injury to pelvis. Past history denied	Pain in the lumbosacral area and legs	Fracture of the symphysis. Prominent sclerosis of right ilium. Slight sclerosis on left
8	24	M	Acute injury to lumbosacral spine following a fall while in training	Pain over the lumbosacral spine on percussion. Noted in midline, nonradiating and subsiding	Left iliac sclerosis
9	30	F	Intermittent lumbosacral pain. Nonradiating and aggravated by effort. Multipara	Negative	Right iliac sclerosis
10	40	F	Nonradiating midline back pain over the lumbosacral area. Aggravated during each of four pregnancies	Negative	Sclerosis of the right ilium
11	25	F	Acute injury to dorsolumbar spine following a fall. Denies previous complaints and has never been pregnant	Pain on percussion of lower dorsal and upper lumbar spine. Follow-up examination after several weeks was normal	Sclerosis of the right ilium
12	24	F	Previous history related to urinary tract. Previous history of back complaints denied	Negative	Circumscribed sclerotic density of the ilium inferior to the right sacroiliac joint
13	36	F	History of acute cholecystitis. Multipara who states that she always has low nonradiating back pain during each pregnancy	Tenderness over the right upper quadrant of the abdomen	Bilateral iliac sclerosis noted on the routine abdominal roentgen examination
14	27	F	Multipara who has low back pain with each pregnancy that subsides following delivery	Negative	Bilateral iliac sclerosis
15	34	F	Six month history of back pain. Noted during first pregnancy. Patient is a gravida 1	Pain over lumbosacral area, sometimes radiating to right hip. No complaints at the six weeks postpartum examination	Bilateral iliac sclerosis
16	41	F	Routine pelvimetry study showed osteitis condensans ilii. Careful history revealed mild, nonradiating, low, midline back pain noted during the last trimester of each pregnancy	Negative. No complaints noted at the six weeks postpartum examination	Bilateral iliac sclerosis
17	42	F	Multipara with low back pain noted during previous pregnancies which subsides following delivery	Normal female in second trimester of pregnancy. Low back pain, lumbosacral area, nonradiating	Bilateral iliac sclerosis

Table I—(*continued*)

18	35	F	Osteitis condensans ilii noted on pelvimetry examination. History of mild low back pain was then elicited	Mild low back pain observed on bending. Seen six weeks postpartum with no complaint	Sclerosis of the left ilium
19	31	F	Multipara with low back pain, nonradiating, worse during last trimester of pregnancy	Normal last trimester pregnant female	Sclerosis of the right ilium
20	25	F	History of mild nonradiating back pain during the last trimester of pregnancy	Normal last trimester primigravida. No complaints at examination six weeks postpartum	Sclerosis of the right ilium

nosed or the condition has not been reported. The finding may be easily overlooked unless search is made for the iliac sclerosis. Case 4 is an illustration of this. The patient was a twenty-one year old male admitted for epigastric complaints. It was noted as an incidental finding on a barium enema study. A careful history failed to reveal any complaints referable to back pain. It should also be noted that a sharply outlined sclerosis is not always seen. The sclerotic area may seem to blend into the adjacent area of the ilium, and this is fairly frequent on the anteroposterior projection. It may be overlooked on this projection, therefore the taking of an oblique projection of the sacroiliac joint will show the process to be more evident. Case 5 demonstrates this finding. The age incidence of our patients is in general agreement with previous authors. The condition is usually seen in young adults and is rarely seen in persons over fifty years of age. Laboratory findings are normal in these cases. Particular attention is given to the sedimentation rate which is elevated in rheumatoid arthritis and is normal in osteitis condensans ilii.

Our case findings are at some variance regarding the usual history and physical findings seen in these patients. The classical finding of this condition in pregnant women, and more frequently in those who are overweight, has not been borne out in our series. It is true that the majority of our female group did have back pain associated with pregnancy, but all were well and denied any complaints at their six week postpartum examination. None of these patients received any specific therapy for their back complaint. This would offer strong support in favor of conservative therapy. Case 11 would seem to refute many previous studies stating that the condition occurred in obese pregnant or postpartum females. The finding of osteitis in this patient was incidental to examination of an acute back injury from a fall. She had had no previous complaints and had never been pregnant.

ROENTGENOLOGIC INTERPRETATION

It is generally conceded that the oblique sacroiliac projections are important to demonstrate the normal joint. Sclerosis of the ilium may frequently simulate sacroiliac involvement, but this may be easily determined by additional projections. Some radiologists prefer stereoroentgenographic pelvic studies as well as the 45 degree cephalad pelvic projection for visualization of the sacroiliac joints. We have found all of these examinations to be useful. Un-

Fig. 1. Case 6. Bilateral iliac sclerosis, more marked on the side of acute injury

Fig. 2. Case 2. Right iliac sclerosis noted in examination of the right hip to exclude a fracture due to acute trauma.

doubtedly the selection of projection is an individual preference.

Case 19 illustrates the clear diagnostic quality of the anteroposterior projection. One would not expect to gain additional information by other projections, and that was found to be true in this case. However, most patients require supplementary projections to determine that the sclerosis is confined to the ilium.

ETIOLOGY

The etiology of osteitis condensans ilii has not been proved. Several theories have been advanced. Berent[2] believed this to be due to pregnancy. This hypothesis has certain defects in that the condition is found in nonpregnant females and in males. Ude[9] noted the occurrence of vertebral epiphysitis in several cases having osteitis condensans ilii. He suggests the possible relationship of the two conditions. This finding was not seen in our series nor has it been recorded by other authors. Shipp and Haggart[7] believe that continued pressure upon the articular surface of the ilium is the cause of increased bony condensation. They state that correction of postural defects may show a reversal in these changes. The possibility of osteitis condensans ilii being due to other osteoblastic bone disease has been considered but no relationship has been found. Laboratory data have not been informative. Bone biopsy has not established a specific etiology.

PATHOLOGY

None of our series had a bone biopsy

Fig. 3. Case 7. (*A*) Pelvic examination at the time of injury revealed fracture of the symphysis. Note the sclerosis of both ilia which is most prominent on the right. (*B*) Forty-five degree cephalad projection of the sacroiliac joints six months following the original examination reveals the typical sclerosis of osteitis condensans ilii involving the right ilium.

and thus far the pathology in this condition rests upon two previous reports.

Rendich and Shapiro[6] report a bone biopsy in a thirty-six year old male, a histopathological study of which showed the following: "Marked condensation of the osseous tissue with obliteration of the evident former lacunae. No over-activity of the osteoclasts or osteoblasts is noted. In fact, these cells are more or less conspicuous by their absence. The marrow spaces contain an unusual number of

Fig. 4. Case 4. Cephalad projection of the sacroiliac joints reveals the classical findings in osteitis condensans ilii. This was discovered as an incidental finding during a gastrointestinal examination. No history of back pain.

myocytic and plasma types of cells. The significance of the plasma cells is undetermined. In general, the lesion appears to be an osteitis condensans type. It is apparently independent of any inflammatory or other etiology, so far as can be ascertained from the histology of the specimen."

Shipp and Haggart[7] disagree somewhat with these findings but point out that the difference may be attributed to a different phase of the same process. They found "that the trabeculations were greatly increased in density but that the lacunae were still readily discernible. Scattered

Fig. 5. Case 5. Anteroposterior projection reveals bilateral sclerosis with gradual fading of sclerosis laterally.

islands of cartilage were observed at a considerable distance from the joint surface. The bone marrow showed focal areas of fibrosis against a normal background. There was evidence of osteoblastic activity in excess of the normal in the form of clumps of osteoblasts and occasional osteoclasts. These findings were thought to rep-

Fig. 6. Case 5. Right oblique projection reveals sharp sclerosis confined to the iliac side of the sacroiliac joint.

Fig. 7. Case 11. Examination of the pelvis for acute trauma in a female who is a nullipara and denied previous back complaints. Right iliac sclerosis which does not involve the sacroiliac joint.

Fig. 8. Case 19. Anteroposterior projection of the pelvis to illustrate the sharp right iliac sclerosis with a clear sacroiliac joint. Most cases will require additional projections to be sure that the sacroiliac joint is normal.

resent a low grade, nonspecific ischemic process."

DIFFERENTIAL DIAGNOSIS

The most important disease from which to differentiate osteitis condensans ilii is rheumatoid arthritis. The apparent sclerosis involving both ilium and sacrum, with poor definition of the intervening joint, may cause confusion. Careful history, physical findings, and laboratory determinations should be helpful in differentiating these conditions. Additional projections of the sacroiliac joint will prevent diagnostic errors. Case 3 of our series could have caused diagnostic confusion, but subsequent studies were completely normal. The roentgenological findings verified the impression of osteitis condensans ilii.

Less common causes for diagnostic error are osteoblastic metastasis, Paget's disease, and septic arthritis. These are usually easily differentiated by the history, other clinical findings, and laboratory data.

SUMMARY AND CONCLUSIONS

The finding of osteitis condensans ilii in twelve females is not unusual. However, the finding of this condition in eight males is rather unusual, judging by previous reports in the literature. It is hoped that this will stimulate more careful observation of this condition. It is believed that the condition is usually asymptomatic. It is also felt that the diagnosis may be mislabeled arthritis in the male and treated as such.

Many of our cases in females are not in accord with the current concept held by some, namely, that some form of treatment may be necessary to cure the back pain arising from this condition. None of our cases had back complaints on their six week postpartum examination. If any treatment is offered, it would seem that it should be conservative or, preferably, that treatment be deferred. It is felt that many of these patients will have no complaints on their follow-up examinations, judging from those seen by us.

Undoubtedly some patients with this localized condensing osteitis will have persistent back pain and will require symptomatic therapy, but it is believed that a search for other causes of the back pain should be instigated. The previously noted

Fig. 9. Case 3. Anteroposterior projection reveals apparent sclerosis of the sacroiliac joint in a young male complaining of back pain for several years. The possibility of diagnostic error in labeling this rheumatoid arthritis is apparent.

Fig. 10. Case 3. Oblique projection reveals a normal sacroiliac joint with sclerosis confined to the iliac portion of the joint. Roentgenologically and clinically the final diagnosis was osteitis condensans ilii.

finding of this condition in pregnant women or postpartum women is believed to be on a coincidental basis. This is inferred by its relatively frequent occurrence in males, and by the benign course of all the cases in our series.

The etiology of this condition is not known. Most theories advanced thus far are not acceptable in the light of subsequent information. Reports of the pathology of this condition have been limited to two cases in the past. Until additional studies become available the condition must remain obscure.

It is the radiologist who plays the important role in the diagnosis of this entity, and it is his responsibility to urge conservative therapy for these patients.

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RADIATION THERAPY*

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AN AXIOM of logic is to define one's terms. Hence, as a generalization, radiation therapy may be defined as any curative procedure utilizing any emission of the light spectrum. We will particularize and confine our interest for the purpose of this presentation to the spectral area beyond the ultraviolet band.

While at this Institute supervoltage roentgen radiation is a major interest, one must recognize the wide range of morbid conditions in which low voltage radiation is useful, indeed almost indispensable.

Some low voltage techniques have not been too widely used as, for instance, the grenz ray (10 kv.). So-called contact roentgen therapy (40–60 kv.) has enjoyed a longer and more useful employment.

When one reflects that 80 per cent of all dermatological conditions are amenable to low voltage radiation, as well as such diverse lesions as boils, carbuncles, bursitis, excess lymphoid tissue, catarrhal deafness, cervical lyphadenitis, parotitis, herpes zoster, Marie-Strümpell arthritis, acute and chronic sinusitis, that certain blood dyscrasias may be controlled and skin cancer cured, such present a fertile field for the radiation therapist even in the event of some overnight discovered cure for deep and metastasizing neoplasms.

It would seem fitting here to acknowledge our tremendous indebtedness to physics and physicists for our progress in radiation therapy, of which some of the younger men may not be aware. It dates back to the close of the nineteenth century when it seemed certain that the atoms of the elements were unchangeable by the forces then at our command.

Then one was thought to be medieval if one did not accept the indivisibility of the atom. With the discovery in 1896 of the radioactivity of uranium and thorium, it was soon made clear that this radioactivity is a sign that the atoms of these elements are undergoing spontaneous transmutation. We were thus given a vision of a new and startling subatomic world.

Rutherford in 1911 first suggested the nuclear theory of atomic structure. In 1919, he found that nitrogen could be transformed by bombardment with fast alpha particles. New discoveries of outstanding importance followed—the discovery of the positive electron by Anderson in 1933, of the neutron by Chadwick in 1932, of artificial radioactivity by M. and Mme. Curie Joliot in 1934, and of the transmutation of the elements by purely artificial methods first shown by Cockroft and Walton in 1932.

It was early recognized that if our knowledge of transmutation were to be extended, it would be necessary to have a copious supply of fast particles of all kinds for bombarding. Enormous numbers of protons and deuterons can be produced by the passage of an electric discharge through hydrogen and deuterium (heavy hydrogen). To be effective for transmutation purposes, however, these charged particles must be given a high speed by accelerating them in a strong electric field.

This led to the development of apparatus to provide voltages as high as one million volts or more, the cyclotron and ultimately atomic fission, so that we end up with neutrons, protons, mesotrons, positrons and neutrinos to balance the books, as Rabi says—a far cry from the concept of the atom of my youth.

Let us retrace our steps to evaluate the physicist in his relationship to radiation therapy. The discovery by von Laue of Munich in 1912 that roentgen rays and gamma rays can be diffracted into spectra by the natural grating contained in the

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orderly structure of crystals set at rest the question as to the nature of these radiations. Von Laue's theory was put to the test by Friedrich in 1912. Soon (1914) Bragg and his son devised the roentgen-ray spectrometer in which a crystal is used as a reflection grating, similar to an optical spectrometer in arrangement, an ionization chamber taking the place of a telescope. The roentgen-ray spectrometer has given us a measure of both the atomic spacing of crystals and the absolute wavelenghts of monochromatic rays.

It was discovered very early (1896) that electrified bodies lost their charges under the action or roentgen rays. This ionizing effect was used for many years by physicists to measure relative intensities of roentgen rays, but the application of dosage measurements appears to have been proposed by Villard in 1908 when he defined the unit of quantity as "that which liberates by ionization one electrostatic unit of electricity per cubic centimeter of air under normal conditions of temperature and pressure." This is essentially the definition which today has been adopted as the definition of the international unit of dosage (the roentgen). However, at that time, it did not meet with much approval and remained unused.

This method was taken up by Szilard and Duane independently in 1914. Szilard constructed a small ionization chamber of 1 cc. volume. The ionization produced in such a chamber was due chiefly to the secondary radiations from the walls and so Szilard did not succeed in reproducing his unit of dosage.

As early as 1905 Duane had pointed out the effects of radiation from the walls of the ionization chamber, and in 1914 he defined his unit of intensity and the method of reproducing it by using a large parallel plate air chamber so constructed that the radiation passing through it struck no solid material whatever. The ionization current was measured by means of a sensitive galvanometer which was calibrated before each observation by means of a standard cell. Duane's unit was defined as that intensity of radiation which produces under saturation conditions one electrostatic unit of current per cubic centimeter of air under normal pressure and temperature. This unit of intensity he designated as E. The unit of dose was the electrostatic unit second written as E.S.

Duane also constructed small secondary chambers for practical use of his unit. I had the privilege of helping to construct one of these when I was fortunate enough to have been one of his first three students in the newly inaugurated course of Radiation Physics at the Graduate School of Arts and Science of Harvard College in 1920. No fundamental improvement has been made over Duane's original method of measurement.

Krönig and Friedrich in 1918 published their excellent work on roentgen-ray measurements. One year later Otto Glasser reported on the determination of equal intensity curves (isodoses) for intracavitary radium. These publications were translated in 1922 by Schmitz of Chicago who, together with Glasser, had worked under Friedrich.

About this time Failla and Quimby were busy and have been ever since with charts and tables of depth dose and tissue dose, in relation to potential, filter, intensity and varying distances for roentgen rays and radium that have been of such tremendous aid to the clinical radiation therapist. I cannot begin to enumerate those in Britain who have played their part, but it would be ungracious to fail to mention the work of Russ, Kaye, Mayneord, and Paterson and Parker.

The unit of dosage was so well established that the roentgen (r) was defined and accepted as an international unit at the International Congress of Radiology held in Stockholm in 1928. In 1937, in Chicago, a comparable unit for radium was adopted, the gamma roentgen.

Contemporaneous with these developments in the realm of pure physics came the evolution of apparatus and tubes designed

by the electrical engineer. First used to produce roentgen rays was the static machine or the induction coil along with a Crookes tube and a fluorescent screen. Do not minimize what was done with what in our eyes would be considered hopelessly inadequate equipment.

I call to your attention a book written by Dr. Francis H. Williams, a graduate of this Institute, and first published in 1901. Working with a static machine and fluorescent screen at the Boston City Hospital, he recognized the discrepancy between heart measurements determined by percussion and roentgen rays. He observed and reported the normal and abnormal excursion of the diaphragm; diagnosed tuberculosis and tumor of the lung, thoracic aneurysm, abscess and gangrene of the lung.

In 1898, Walter B. Cannon, while a student at Harvard Medical School, made some observations on the digestion of cats and assisted Williams in the examination of the stomachs of two children, employing bismuth subnitrate as a contrast medium.

Williams treated epidermoid carcinoma of the lip successfully and was the first, as far as I have been able to learn, to enclose his treatment tube. The inner aspect of the tube shield was coated by lead paint. He employed diaphragms to limit the field and even used an aluminum filter.

The coating of lead paint was suggested by William Rollins who collaborated with Williams. I happen to have here, which appeared in 1902, Rollins' book, "Notes on X Light," a survey of his experiments made, by the way, after the day's work. Rollins was a graduate of the Harvard Dental and Medical School. Anyone interested in the history of radiology should make it a must to read both these books. Rollins in 1897 described a continuously water-cooled anode and, in 1898, a rotary target, and the following year his "See Hear," an apparatus for hearing the sounds made by the heart and lungs when the organs are being examined by "X light." He also suggested the use of roentgen to identify criminals by examination of the bones of the hands and feet.

I remember a candidate appearing before the American Board of Radiology who was asked by an examiner who Francis Williams was. Although he had worked for three years in a department dedicated to Francis Williams, he had never heard of him. Sic transit gloria! Francis Williams went to the Paris Exposition (1905), where he purchased a very large static machine. Meanwhile, the interrupterless transformer was developed by Snook (1907). On the arrival of the Paris-purchased static machine at the Boston City Hospital, it was never uncrated and Francis Williams turned his attention from roentgen rays to radium therapy, which interest he maintained until his death.

With the advent of the interrupterless transformer, came the autotransformer, the Coolidge hot cathode tube, and the self-rectifying Coolidge radiator tube. In 1919, the Waite and Bartlett oil immersed shock proof unit was developed. The kenotron hot cathode type valve was introduced in 1914, but it was not until 1930 that it began to occupy an important place in the roentgen-ray field.

In 1931, a special induction coil type of transformer was designed for use at the Memorial Hospital, New York City, with a capacity of 700 kilovolts at 5 ma., and one at Mercy Hospital for 800 kv. at 10 ma. Shock proof 400 kv. apparatus was in general production; then came the electrostatic generator of the belt type producing 1,000 kv., the frequency resonance transformer of Charlton and Westendorp, the betatron of Kerst and now the synchotron 70 mev.

The million volt electrostatic generator of the belt type, of which some part or other of the high voltage circuit is in the open air, was, when first designed by Van de Graaff and Trump, so large as to require a special building to house it. It might well be described as a glorified static machine. A cascade type of roentgen tube, continuously pumped by means of a mercury vapor diffusion pumping system, was em-

ployed. It was first used clinically at the now abandoned Huntington Hospital. Later, due to the ingenuity of these physicists and electrical engineers, the potential of their apparatus was increased to 2,000 kv. with the generator and tube enclosed in a compressed gas casing of reasonable dimensions.

Hardly had we become adjusted to this progress when we were introduced to the cobalt 60 bomb and now the 50 gram radium pack unveiled today at the opening of the new Janeway Cancer Unit at the Roosevelt Hospital in New York.

I cannot devote as much attention to cobalt 60, radioactive isotopes and their hazards as the subject demands.

Someone not so long ago made the statement that compared with cobalt, radium was as "outmoded as a Model T Ford" in the treatment of cancer.

When it is stated that cobalt 60 can be purchased for one five-hundredth to one one-thousandth of the price of radium, we should remember that that is possible only when the cost of the atomic pile ($2,000,000,000), the cost of keeping the atomic pile operating (several million dollars a year) and 50 per cent of the actual handling costs for the preparation of this radioactive isotope are written off.

As a matter of fact, as far as radiation is concerned, it is almost impossible to distinguish between that from a 2,000,000 volt roentgen-ray machine and that from the 1,000 curie cobalt 60 pack, on the one hand; on the other, for small sources, the radiation is very close to being the same as that from radium. Therefore, there is no new modality at all. It offers no substitute for radon. The inestimable value of the latter as gold implants can only be appreciated by the initiated.

Radium element needles are a constant for all practical purposes and are as useful today as they ever were, which is directly proportional to the experience of the one using them. Individual physicians and hospitals have purchased radium at a high price over the years and have a substantial interest in it.

It does not make sense to jeopardize these investments by ill-advised statements or to minimize the benefit accomplished by radium, so that physicians must apologetically explain to patients why they use radium instead of cobalt 60.

By the time one obtains cobalt 60 from the Atomic Energy Commission and fashions it into this or that kind of an applicator requiring the expert services of laboratory mechanics and a physicist to measure it, its cheapness will have vanished into thin air.

"Cheap cancer treatment" was the headline recently in one of our Northeastern dailies pretending to evaluate cobalt in the treatment of cancer. It brings to mind the thought how cheap is cheap cancer treatment, and is cheap cancer treatment cheap at any price?

Even the science reporter of the *New York Times* can write nonsense. Describing a cobalt 60 bomb as worth about $50,000, he gratuitously says it can do the work of a 2,000,000 volt x-ray machine. This is purely a mathematical assumption. Very little clinical work has been done with it. No five year end results have been published, because there are none. He complains that a radium bomb is bulky, but then goes on to say that a cobalt bomb is housed in a lead casing a foot thick which requires heavy machinery to operate it and must be protected against a direct beam by a wall of 40 inches of concrete. He does not, of course, estimate the cost of any of this. Further, a cobalt bomb will be dying in three to four years, so that another must be substituted, something that does not apply to the radium bomb.

There is no reactor or atomic pile in this country able to supply more than minimum amounts of radioactive cobalt. The Chalk River "pile" west of Ottawa is the chief source of cobalt 60 in any quantity in this hemisphere. Cobalt 59 must be left for at least six months in the Chalk River reactor to be transmitted into cobalt 60.

Aebersold, of Oak Ridge, is in agreement with Failla and Quimby that there is very

little point in using an artificially produced radioisotope, such as cobalt 60, only as a cheap source of radiation, just as a substitute for radium.

Cobalt 60 has certain disadvantages. The first is its comparatively short half-life—5.3 years. This means that from time to time corrections for decay must be made. Further, there is little difference between the energy of the gamma radiation from cobalt 60 and the energy of gamma rays from radium. Consequently, although there might possibly be some advantage in using cobalt 60 because of the uniform energy of its gamma rays, Aebersold doubts that this can be demonstrated. He points out it is not commercially available as is radium. At present, it is only available to those institutions which have the facilities for research and clinical care of patients, as well as a trained personnel to use the material. In other words, it is available right now primarily to those clinicians in a position to carry out special measurements and clinical developments rather than routine application.

It must be stressed that no matter how far medicine may develop as a science, the successful treatment of the sick will always be an art. Science has progressed and expanded marvelously during these past few years. Its dramatic strides have so fully occupied the public mind that there exists a tendency to attach undue importance to the servant, Science, and forget the mistress, Art, without whose adaptation of scientific discoveries to human use the greatest of scentific triumphs would be of no avail. The ability to measure finely and precisely is sometimes held to be of more importance than the thing to be measured. This is confused thinking. It is the place that is important—not the fact that every dimension is exact to one millionth of a millimeter.

And neither may science take the place of art; given the most scrupulous analysis of the pigments—the most precise measurement of each color and shade, and most of us would still be unable to produce the paintings of a Goya or a Velazquez. These bits of information might help but they would not make artists of us. The artist must have a knowledge of human needs and desires and these are so infinitely variable that they may not be reduced to any unit of measurement. Such knowledge can come only from sympathetic observation enriched by experience.

Some of this confusion has crept into the consideration of the therapeutic use of roentgen rays and radium. It is not my intention to minimize the importance of scientific study. It is my desire to indicate the error of leaving the path of clinical experience to follow too far along a road paved with fascinating numbers. It is not clear thinking to believe that in order to successfully apply radiation in the healing of the sick, a man must be an expert mathematician. He *may* have these accomplishments, he *must* have a knowledge of the human body and clinical judgment.

During the early days radiation was applied at one seance, sometimes of several hours' duration. This treatment resulted in improvement in some cases, failure in many more. The failures were attributed to insufficient treatment and the tendency was to apply even greater quantities of radiant energy. This tendency was checked by the occurrence of unpleasant and dangerous systemic reactions such as nausea, hemorrhage, etc., also severe local destruction of the skin.

It was thought that the systemic reactions were to some extent unavoidable and perhaps necessary, but most radiologists were forced to divide their treatments over four to six days. This corrected the systemic aspect but did not lessen the danger to the skin and subcutaneous tissues. Rather, it was increased because no longer inhibited by symptoms which became apparent during the course of treatment, even larger quantities of energy were applied than before, to be followed a week or ten days later by unexpected and very serious skin damage. There was some increase in the number of cases improved by the treatment;

still there were many failures, yet the belief persisted that failure was due to insufficient treatment.

With the establishment of a standard of measurement more accurate than that previously employed to describe dosage, it was felt that there was some upper limit to the amount of radiation the tissues might receive without irreparable damage, and that such damage as occurred was due to inaccurate description of dosage employed and inaccurate reproduction of the various physical factors by those who were trying to reproduce clinical results.

It then became evident that there were other factors which had to do with clinical results. First was the quality of the radiation, or its penetrating power, which governed the distribution of absorbed energy within the tissues; second, the manner in which the treatment was administered, whether in one day, in six days, or in sixty days.

Obviously, the body tended to repair local tissue damage and the more opportunity given for repair between treatments and the less the severity of the treatments, the greater the total intensity of radiation which might safely be given.

Biological experiments were performed to fix an average value for recovery rate. This latter value was never satisfactory for clinical use, which was probably not so much due to lack of care and refinement of measurement in the experimental work as to the usual difficulty of trying to deal with human beings in terms of an average, to which the individual never exactly conforms.

We learned two facts which might have been predicted: first, the upper tolerance limit would always be widely variable—not because of failure to measure and observe accurately, but because individuals vary widely in their resistance to radiation changes as they do to every other type of treatment, and, second, that there is a variation in individual recovery rates.

Also during this period of development two very interesting observations were made. The first was that for certain types of tumor the number of clinical improvements increased as the quality of the radiation was made more penetrating. This could be accomplished by increasing filtration. At each voltage there is a limit to which filtration may be carried without reducing intensity below the economic limit. Consequently, voltages were increased from the customary 200 kv. to 400 kv., 800 kv., and higher.

There is a difference of opinion as to the reason for this improvement in results. By some, it is attributed to better distribution of absorbed energy in the tissues; by others, to some specific property of the shorter wavelengths. Now that the higher voltages are comparable to the gamma rays of radium, opinion favors the latter view.

Whatever it may be, the clinical radiologist will be guided by his knowledge of the natural history of the disease to be treated, the subjective symptoms of the patient and objectively by the known observable histological variations which follow irradiation.

One must constantly have in mind that cancer is not a specific entity as the word is used today, but rather something generic. It encompasses all neoplasms of the skin and its integuments, the mucous membrane, muscle, bone, lymphoid tissue and the so-called blood dyscrasias. Hence, it is readily seen how diverse and nonspecific the ideal of a cancerocidal dose or a standardized treatment must be.

Ewing has pointed out that different organs exhibit different grades of susceptibility to radiation as to their structural integrity, that disturbance of the body's delicately balanced circulation has often been revealed as the modus operandi of many cancer cures as well as of many spontaneous regressions. Unless the tissues react by proliferation of lymphocytes, plasma cells and active growth of new capillaries which surround and compress much of the deeper parts and mechanically extrude the degenerating cells, under some circumstances, when this reaction fails, no amount

of radiation succeeds in killing the tumor cells.

In certain types of tumors the result of radiation treatment seems to depend upon the administration of larger intensities which can be accomplished without toxemias or severe inflammatory reactions by giving small treatments each day over a great number of days. This would suggest that from a certain severity of treatment the recovery of the normal tissues is more rapid than that of pathological tissues and that advantage may be taken of this differential recovery rate, so that when finally the cumulative dose for the tumor may be lethal, that of the intervening and surrounding tissues may be far from that point.

To cure by selectively destroying diseased tissue while at the same time sparing normal structures, that is the ideal striven for.

The electrostatic generator of Van de Graaff and Trump is a unique unit combining flexibility and economy of size without affecting radiation quality. It operates at a target current between 0 and 500 microamperes. At 2,000 kv. and the conventional treatment distance of 100 cm., the output is 70 roentgens, as measured in air. The half-value layer in copper is 13 mm.

The two outstanding characteristics of supervoltage are an increase in skin tolerance and an increased percentage depth dose.

The increased skin tolerance is mainly due to high speed, high energy photons which produce in tissue long range supercharged secondary electrons. These electrons require tissue density greater than their mean range before ionization is complete. This cannot occur at the surface. Since ionization is responsible for the changes we observe, its deficiency on the skin readily explains this first physical characteristic. The equilibrium reaction occurs ·2–3 millimeters below the surface.

Penetration is an inherent property of ionizing radiation and increases with the voltage applied. This will explain the increase in depth dose.

Furthermore, there is a minimum of tangential and circumferential scattering. Almost all scatter is in a forward direction. This improves the useful beam. It yields a more geometrical path of ionization, at the same time sparing to a greater degree intervening normal tissue

A word of caution. The skin no longer is a limiting factor. Clinical judgment and deep tissue reaction, especially within mucous membrane, must be our guides. If a crossfire technique is used, the increase in the exit dose must be considered.

Lastly, protection factors especially within the limits of the useful beam are going to be totally different. No longer will a thin strip of lead rubber or a few millimeters of lead be sufficient to protect the patient. The protection of personnel and adjoining rooms also presents a new problem.

Acknowledging the physical properties of supervoltage roentgen rays it remains to assess their value to the therapist and his patient. The common denominator here, as with any mode of cancer treatment, is the response of the tumor. This is known as the biological effect. In radiation therapy this is produced as the roentgen rays interact with matter. More precisely, it is the number of roentgens which are absorbed in a given volume of tissue over a stated period of time. It is the cellular alteration which takes place in this tissue. Is this reaction or is the clinical result with 2,000 kv. (peak) going to differ from that observed with 200 kv. (peak), assuming an equal dose in each instance?

Trump and others feel that the biological effect is the same below the surface of the skin regardless of the quality of the incident beam. Theoretically then, supervoltage roentgen rays hold no advantage in tumor response. In all fairness, it must be stated that no one to date has properly been able to handle this wavelength in a precise manner. Too often the lesions were too far advanced to be of any comparative

value. Too often too small a series of cases were treated.

We have been familiar with 1,000 kv. therapy for twenty years. Schulz, after eight years' experience, states that no real advantage accrues from supervoltage as far as curing a greater number of cancer patients is concerned.

It would appear rational to expect that supervoltage roentgen rays will produce in tissues below the skin the changes peculiar to ionizing radiation at the surface. Schulz warns against the skin damage which appears late in the posttreatment phase. I will take it for granted that you are familiar with the damage to the mucous membrane of the intestines, bladder, and rectum and even the spinal cord from ultra high voltage as reported in the literature.

A word or two as to rotation therapy. To my mind, this combination of a supervoltage beam with a core of ionization is the ultimate in technical perfection.

Crossfiring or multiple small beam therapy using supervoltage has been found very satisfactory, provided the number of sites of entry are four or less and some thought has been given to treatment planning. However, when more than four fields are employed, it becomes almost technically impossible to reproduce the physical set-up, no matter how great is the control of the patient. Even when using light defining mechanisms built into so many of the present day machines, there is the very real danger of "hot spots" and poor centering.

Furthermore, if supervoltages of 1 and 2 million volts are used, crossfiring particularly may be hazardous due to the high exit dosages characteristic of these wavelengths.

Nielsen and others working with 200 kv. carried the idea of multiple small field therapy to its ultimate refinement. They rotated a patient about an axis perpendicular to the plane of the primary treatment beam. This allowed them to deliver to a lesion in the thoracic esophagus a dose almost 50 per cent again as large in the same period of time as was given with a technique using multiple fields.

Here at Massachusetts Institute of Technology this very plan is in operation. Rotation is combined with a highly penetrating, well defined beam of ionization. Rotation further enhances the qualities of supervoltage by virtue of its reduction in the damage to the skin and intervening tissues. Therefore, this combination, if properly understood, should allow the therapist to deliver to a certain group of tumors doses of radiation previously unattainable in comparable periods of time. It would seem ideally suited to treatment of midline deeply situated lesions, such as those in the esophagus, mediastinum, pituitary, nasopharynx, hypopharynx, bladder and perhaps the cervix.

Briefly, this is a summary of a treatment plan. Let us assume the patient has a carcinoma of the middle third of the esophagus. Fluoroscopically, the extent of the lesion is mapped out in the treatment position which is upright. Appropriate marks are placed on the patient's skin. The patient is lined up in two planes at right angles one to the other and roentgenograms taken with the treatment machine and the centering of the lesion checked against the previous sighting. Once the lesion is properly centered, indelible markings corresponding to the treatment area are placed on the patient. The light-defining mechanism of the roentgen-ray beam is turned on and the field size properly set up. The primary beam in all cases is interrupted or actually molded by the use of ingenious positioning of variously shaped lead filters to cut out the beam where it may pass through vital structures (viz., spine, eye, lung, etc.) otherwise impossible to remove from the primary beam without materially reducing its effectiveness. Once this is done, the patient is secured firmly in position. As the patient is rotated, the room is darkened and the beam of roentgen rays defined by the light beam is watched by the operator from an adjoining room. The patient is rotated very slowly, about one revolution per minute. For the average

patient this means that any one portion of his skin will be in the direct path of the beam probably for no more than a second and a half. The lesion will be within the beam all the time. The intervening tissues will be exposed for varying lengths of time dependent almost entirely on the size of the portal of entry. There will be greater exposure of normal tissue, the greater the field size.

Tissue dosage is calculated as with any other method employing radiation. The 100 per cent zone instead of being measured at the surface of the skin, is measured at the center of rotation and is known as the "axis air dose." This is a distance of 122.5 cm. away from the target. Estimation of tissue dose or axis tumor dose is made on cross section charts drawn to scale and superimposed on a 360 degree circle. The dose to any given point in or about the tumor site is calculated considering the portals of entry as discontinuous. The contribution of each of these fields is summated yielding the true estimate of the delivered dose.

The lesion (esophagus) to be treated, if the patient is 20 cm. in the anteroposterior diameter and 28 cm. from side to side and the lesion is considered to be 7 cm. away from the posterior chest wall and 13 cm. away from the anterior chest wall, will receive a tumor dose of between 5,000 and 6,000 r within a period of thirty to forty days without any damage to the skin. There should be no appreciable damage to the lungs, since the portals used are quite narrow (10 by 6 cm.). The dose to any portion of the skin in this case, which would require an air dose of at least 8,500 to 10.000 r. will be about 60 r.

It must be re-emphasized that, despite rotation and supervoltage, unless attention is paid to the distribution of ionizing radiation in the tissues, especially significant with this newer method, unpresaged trouble may occur.

I have tried here this evening to present an accolade to the physicist without whom radiation therapy would not have reached its present enviable position. On the other hand, I know the physicist in all humility says his efforts would be fruitless without the clinical judgment of the radiation therapist.

I would not be honest with myself if I did not say here I deprecate the growing custom of our times indulged in by universities, hospitals, lay organizations and individuals of presenting the advances and discoveries, alleged or otherwise, of medicine in the public press instead of in accepted medical journals, their rightful place.

May I close with a word to all you younger men going into the field of radiation therapy. You will be practicing medicine. I remember before taking up the study of medicine, I consulted a distinguished New York physician who recalled to me that "cure" comes from the Latin, "cura," care for, have anxiety for, have solicitude for. That is the rewarding part of radiation therapy. You take care of patients. To quote Robert Newell, a scientist in his own right and an outstanding radiologist, "There is nothing that so convinces us that we are important and necessary as the patient who leans on us—and us alone—for the relief of his affliction or actually in fear of his life." Always display a proper amount of humility and tact. "If your consultant is wrong, try not to make him change his mind in public—it's as hard to take as changing one's pants in public."

"Courage is the cornerstone of character. How we admire the man who stands up for himself when he knows he is right. The only thing we admire more is the one who stands up for another, because he knows that other one is right."

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EXPERIENCES IN THE RADIATION THERAPY OF MEDULLOBLASTOMA OF THE CEREBELLUM

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In September, 1949, the authors[4] reported 25 cases of medulloblastoma of the cerebellum treated by operation and irradiation during 1938 to 1945 inclusive. Eighteen of the patients had died, 9 within the first year after treatment, 13 within two years and 16 within three years. One patient died thirty-eight months and 1 sixty-eight months after treatment. Seven patients were alive, at thirty-three, forty-seven, fifty, seventy, seventy-two, eighty-three and ninety-two months after treatment. The present report is concerned with the subsequent fate of these 7 survivors.

In 1946 another patient three years old with medulloblastoma of the cerebellum was operate upon and a gross total removal was performed. This patient was irradiated postoperatively but died six months later. This patient is added to the series, making a total of 26 cases treated from 1938 to 1946 inclusive.

The details of the technique of irradiation have been given elsewhere.[4] Briefly the method of treatment consisted of daily irradiation of two lateral fields covering the posterior half of the skull with doses of 250–300 roentgens (measured in air) to each of the two fields for a total dose of 1,750 to 1,800 r (air) using 200 kv., half-value layer 0.9 mm. Cu, at a distance of 50 cm. Then two lateral fields covering the anterior half of the skull were treated in the same manner. The next segment consisted of two fields over the upper two-thirds of the spine to which like daily and total doses were administered. During the last phase of treatment a third spinal field was irradiated with the same daily and total doses. In some patients while the third spinal field was treated additional irradiation of the posterior skull fields was carried out raising the total dose to each of these fields by 400 to 500 r.

The 7 patients who were survivors at the time the previous report was written are still alive, at $6\frac{1}{3}$, 8, $8\frac{1}{12}$, $9\frac{1}{6}$, $9\frac{1}{2}$, $10\frac{3}{4}$ and $11\frac{1}{12}$ years after beginning of radiation treatment. Because of interest which naturally centers on such long survival of patients with medulloblastoma of the cerebellum, abstracts of each case history are presented.

REPORT OF CASES

Case 1. P. M. (No. 458135), female, aged nine years, admitted March 13, 1940, with history of headaches for eight months, projectile vomiting for three months, anorexia and confinement to bed for one month. Physical examination revealed an acutely ill child. Positive findings included a positive Romberg test, wide-based, staggering ataxic gait, bilateral papilledema, coarse nystagmus, slight weakness in left extremities, dysdiadochokinesia of the left hand, past pointing to the left and hypoactive reflexes most evident on the left. Skull roentgenograms showed signs of increased intracranial pressure.

The clinical impression was a cerebellar neoplasm, probably in midline, involving the left side more than the right. Ventriculography was not considered necessary and a suboccipital craniectomy and incomplete removal was performed on March 15, 1940 (Dr. Carl F. List).

At operation the surface of a soft, highly vascular tumor was encountered at a depth of 2.5 cm. in the left cerebellar hemisphere. As tumor tissue was removed it was discovered that the lesion arose from the roof of the fourth ventricle and extended into both cerebellar hemispheres but more into the left than the right. The neoplasm infiltrated the lateral portions of the floor of the fourth ventricle, especially on the right side. These portions could not be removed but the rest of the lesion was re-

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moved. The dilated aqueduct was seen through which fluid pulsated from above.

The tissue was examined by the Department of Pathology (Dr. L. Catron) and by the neuropathologist (Dr. K. Scharenberg) of the Neuropsychiatric Institute and in both instances the diagnosis of medulloblastoma was made.

The postoperative course was not unusual and roentgen treatment was started on April 1 and completed on April 30, 1940. The patient was discharged in fair condition.

The patient never returned but was under the care of local physicians. Reports of the patient's condition were submitted throughout the period of follow-up. They are summarized as follows:

After her return home the patient's strength improved but occasional vomiting occurred in May and June, 1940. During the winter of 1940–1941 she suffered severe headaches. She improved and felt well during the summer of 1941. In the fall of that year she was reported to have acted queerly and to have "lost her mind" for one week. Although she was not able to read or write after returning home, she was otherwise alert mentally until this episode. Two months later she was again seriously ill with headaches, vomiting, blindness, deafness, high fever and delirium. Convulsive seizures first developed during the summer of 1944 following a year of good health. In 1945 grand and petit mal seizures were reported. These convulsions have continued until the date of last follow-up information of January 10, 1951. By 1947 she was almost totally blind and was unable to dress or feed herself or walk about the house and was losing weight (weighed 87 lb.). In 1949 she was described as being absolutely helpless, almost totally blind, weighing 65 pounds, but her mind was still clear. By October, 1950, she was unable to express herself. The last follow-up report is dated January 10, 1951: progressive mental failure, unable to differentiate day from night and does not understand anything that is said to her; at times talks continually but nonsensically; continued convulsions.

Summary. Subtotal surgical removal of medulloblastoma with postoperative roentgen treatment. Alive ten years and nine months after radiation treatment but a helpless invalid who has shown progressive physical and mental deterioration with convulsions for almost seven years. Onset of convulsions four years after treatment.

Case II. V. D. (No. 464563), female, aged eighteen, admitted July 6, 1940, with three months' history of increasingly severe occipital headaches and staggering gait. Vomiting, not projectile in type, began several weeks after the onset of headache. Diminution in vision was noted two to three weeks before admission. Examination showed bilateral choked discs; slight horizontal nystagmus to the left and slight vertical nystagmus upward; finger-to-nose and heel-to-knee tests were unsteady bilaterally, especially on the left; mild bilateral hypotonicity of the extremities; considerable ataxia on standing and walking with tendency to stagger to the left; falling to the left in Romberg position; diadochokinesia fair. Routine skull roentgenograms were negative. Ventriculography showed moderate internal hydrocephalus; the fourth ventricle was well defined and displaced to the left. On July 25, 1940, a right suboccipital craniectomy was performed with gross total removal of a tumor arising from the roof of the fourth ventricle extending chiefly into the right cerebellar hemisphere (Dr. Carl List).

At operation at a depth of 2.5 cm. in the right cerebellar hemisphere a grayish, highly vascular tumor was encountered. Macroscopically it appeared to be a medulloblastoma. The tumor involved the roof of the fourth ventricle and extended to a greater extent into the right than the left hemisphere. The floor of the fourth ventricle was not involved. All gross evidence of tumor was removed widely, exposing the floor of the fourth ventricle and the aqueduct. Escape of fluid from the aqueduct into the fourth ventricle was noted.

Pathological diagnosis by the Department of Pathology was medulloblastoma (Dr. C. V. Weller and Dr. R. C. Wanstrom).

Roentgen treatment was started on August 6, 1940, and completed on September 6, 1940. During irradiation the patient experienced temperature elevation, nausea and vomiting which gradually subsided. The patient left the hospital in excellent general condition but with residual ataxia of the right extremities due to removal of tumor and overlying cerebellar tissue.

The patient returned on October 25, 1940, having felt well until two weeks previously when she developed anorexia, nausea and

vomiting. Examination disclosed the patient to be well nourished and in no distress. Alopecia with pigmentation and scaling of the scalp was present and a gait typical of a cerebellar syndrome. The patient was placed on a dry diet with disappearance of the nausea and vomiting.

The patient was re-admitted on November 25, 1940, because of progressive ataxia, weakness, headaches, diplopia and difficulty in voiding. Beyond slightly choked discs, there were no new neurological findings. A ventriculogram on November 29, 1940, showed internal hydrocephalus and only questionable evidence of recurrent tumor on the left. It was felt that another suboccipital exploration was not justified and a third ventriculostomy was done on November 30, 1940, as a palliative measure to reduce the internal hydrocephalus and the increased intracranial pressure. Following this, the headaches disappeared.

The patient was seen on February 6, 1941, at which time she had no headaches or nausea and vomiting. Bilateral mild secondary optic atrophy and right-sided cerebellar symptoms as before were present but she was able to walk fairly well without support. Additional examinations during 1941 and 1942 showed that the patient continued to be in good general condition, had gained weight, and her neurologic status remained unchanged. She attended school.

On October 24, 1945, the patient's general physical condition was good. The scalp was partially epilated. Neurologic findings were as before except for increased cerebellar symptomatology. She gave a history of two attacks during which she "felt numb all over and could not move or talk." She was teaching school. During 1946 and 1947 she was attending college and reported her health to be fine and stated that her gait had improved.

On February 7, 1948, she suddenly experienced vertigo and became unconscious. Left hemiparesis and left homonymous hemianopsia as well as cerebellar signs were found on hospitalization. A ventriculogram on February 11, 1948, showed moderate symmetrical dilatation of the ventricular system without deformity or displacement. By February 12, 1948, a total left hemiplegia was present. February 17, 1948, left sided jacksonian convulsions occurred. A right internal carotid arteriogram on February 18, 1948, showed no abnormality. By March 11, 1948, she showed improvement which was considerable three days later. (The patient was under the care of Dr. Carl F. List at a hospital in Grand Rapids, Michigan, for this episode.) She made a slow recovery but eventually the hemiparesis cleared up practically completely. The cerebellar signs continued.

Throughout 1949 and 1950 she reported she was feeling fine but that she lost her balance easily and had to be very careful when she walked. She was last examined by Dr. List on September 12, 1951, and showed no evidence of recurrent disease; at this time she complained of low backache for which no cause could be found.

Summary. Gross total surgical removal of medulloblastoma followed by roentgen treatment. Alive $11\frac{1}{2}$ years after radiation treatment. A symptomatic episode four months after operation, apparently due to stenosis of the aqueduct, was overcome by a third ventriculostomy. With subsequent survival of over a decade, recurrent tumor as the cause of this episode seems excluded. An apparent vascular accident occurred $7\frac{1}{2}$ years after radiation treatment. Patient's condition on last examination was good except for low backache and difficulty in walking.

CASE III. R. S. (No. 492565), male, aged fourteen, admitted November 1, 1941, with a history of dizziness five months before, headache for six weeks, and nausea, vomiting, diplopia and blurring of vision for two weeks. Physical examination revealed bilateral papilledema, nystagmus, tendency to past pointing and slightly staggering and broad-based gait. Skull roentgenograms showed prominent digital markings and widening of the coronal suture. Ventriculogram showed a midline cerebellar lesion. On November 5, 1941, a suboccipital craniectomy with gross removal of a tumor was done (Dr. Max M. Peet).

At operation a tumor was encountered in the right cerebellar hemisphere at a depth of 2 cm. The tumor extended to the midline, invaded the roof of the fourth ventricle and also the left cerebellar hemisphere. All visible tumor was removed. It was about the size of a small lemon and appeared to have arisen from the roof of

the fourth ventricle, invading its lateral walls and both hemispheres.

The removed tissue was examined in the Department of Pathology (Dr. C. V. Weller) and in the Department of Neuropathology (Dr. K. Scharenberg); both rendered a diagnosis of medulloblastoma.

Postoperatively it was necessary to relieve increased intracranial pressure by lumbar puncture on one occasion. By November 12, 1941, the wound was well healed. Roentgen treatment was started on November 14, 1941, and completed on December 13, 1941. There was anorexia throughout the period of irradiation with occasional nausea and vomiting.

The patient was seen again on September 15, 1942, with interval history of continued improvement and weight gain. Examination revealed a well developed, healthy looking boy with slight nystagmus on extreme right gaze, slight dysdiadochokinesia of left hand and normal finger-to-nose and heel-to-knee tests.

On September 12, 1943, the patient developed neck pain, fever of 102° F. and vomited on two occasions. He was admitted on September 20, 1943, with complaint of sore neck and loss of use of the right arm. Examination showed hair to be sparse except at the vertex of the skull. Nystagmus was still present. The neck muscles, including both trapezius muscles, were weak; right upper extremity muscles were markedly weak. Also there was weakness of the shoulder girdle muscles and winging of both scapulae. Definite Kernig's reflex bilaterally. No definite ataxia. A diagnosis of poliomyelitis was made and the patient was discharged on September 30, 1943, without significant change.

Letters from his physician in 1945 and 1946 reported general health to be good. The patient attended school regularly but his mental ability was somewhat impaired. Alopecia, weakness of the arm and pronounced torticollis were present. Patient exhibited frequent periods of depression and temper tantrums which appeared to be related to poor psychic adjustment to the pronounced neck deformity (torticollis) and the alopecia.

In 1947, it was reported that he was well and working; torticollis and alopecia persisted. This situation has persisted and the last follow-up information dated January 30, 1951, stated that the patient's health was good and that he was able to work.

Summary. Gross total surgical removal of medulloblastoma with postoperative roentgen treatment. Alive nine years and two months after radiation treatment. Approximately two years after this treatment, patient had poliomyelitis resulting in severe torticollis. Apparently patient has shown some mental impairment but is in good general health and able to work.

Case iv. S. N. (No. 495466), male, aged twelve, admitted December 27, 1941, with history of increasingly severe headaches, alteration of gait, impairment of vision and weight loss over a period of four months with more recent development of nausea and vomiting. Physical examination showed a chronically ill, well developed white male with typical signs of a fourth ventricular tumor: bilateral choked discs—4 diopters swelling, pronounced horizontal nystagmus and slight upward nystagmus with incoordination and mild paresis of conjugate lateral and vertical eye movements, bilateral mild sixth nerve weakness, slight lagophthalmos on right indicating minimal facial weakness of peripheral type on right, considerable static ataxia when standing and walking, with greater deviation tendency to the right, mild kinetic ataxia and dysdiadochokinesia of both arms and legs and past pointing with both arms, especially the right one, outwards. Skull roentgenograms showed slight sutural separation. Ventriculography was not done. On January 2, 1942, a suboccipital craniectomy was carried out with subtotal removal of a tumor of the fourth ventricle which extended into the left cerebellar hemisphere (Dr. Carl F. List).

At operation, a grayish-red nodular tumor was found at a depth of 2.5 cm. in the medial part of the left cerebellar hemisphere. The tumor was soft and had the characteristic appearance of a medulloblastoma. It was the size of a large plum, filled the entire cavity of the fourth ventricle and also spread somewhat to the right side. A free flow of ventricular fluid through the aqueduct was established following removal of the tumor, but a portion attached to and infiltrating the lower half of the floor of the fourth ventricle could not be removed.

Postoperatively there was evidence of a right peripheral seventh nerve palsy, lumbar puncture was necessary on several occasions, and pneumonia developed at the left base and cleared on treatment with sulfathiazole. Exposure keratitis of the right eye was treated by

tarsorrhaphy on January 22, 1942. Roentgen treatment was started on January 13, 1942, and completed on February 11, 1942.

The pathology report on the excised tissue was "a neoplasm of poorly differentiated cell type. The cells are round or slightly oval. A medulloblastoma" (Dr. R. C. Wanstrom). The same diagnosis was made in the Department of Neuropathology (Dr. K. Scharenberg).

The patient returned in August, 1942. He was feeling well, appetite was good, was able to ride a bicycle and play games. Examination showed roentgen epilation, bilateral secondary optic atrophy as result of the previously choked discs. Visual acuity was: O.D. 6/30, O.S. 6/15+2. He still had a complete right facial paralysis (nuclear or radicular) and also a nuclear sixth nerve palsy on the right combined with paralysis of the lateral gaze to the right. In addition, there was supranuclear involvement of the right internal rectus. The extremities were hypotonic. There were moderate bilateral cerebellar signs but no past pointing or gross ataxia on finger-to-nose testing. The gait was still broad based and slightly unsteady. The neurosurgeon stated that the residual neurological findings were due to injury of the floor of the fourth ventricle on the right side when the tumor was removed; there was no evidence of neoplastic recurrence. Re-examination two years later (October 20, 1944) showed the status of the cranial nerves to be unchanged, bilateral optic atrophy and nystagmus as before. The cerebellar signs were only mild; station and gait much improved. Vision: O.D. 6/30, O.S. 6/9+2; with glasses O.D. 6/12, O.S. 6/12. He felt well and attended school (9th grade).

The patient continued to do well; in 1947 he was a senior in high school and a good student. This state continued until June, 1949, when he had a generalized convulsion. Two and one-half weeks before admission (October 9, 1949) to the hospital, frequent left-sided convulsions began. These started in the mouth and progressed to involve the whole side. He also developed apathy, nausea and vomiting, and left-sided weakness. On physical examination the patient was quite drowsy, slow to answer questions and obey commands. In addition to the previous persisting neurological changes, a left hemiparesis was present with increased deep reflexes and absent abdominal reflexes on the left. Pain was perceived bilaterally. Finger-to-nose test on right was good but on left could not be tested because of weakness. He was unable to stand without falling.

A clinical diagnosis of recurrent medulloblastoma was made and patient was referred for additional roentgen treatment. Because of the long interval of apparent freedom from neoplasm (almost eight years), this diagnosis was considered unlikely to be correct and the patient was not accepted for treatment. It was considered that late radiation brain changes were most likely the cause of his symptoms; complete investigation even to the extent of an exploratory operation was recommended.

An electroencephalogram on October 14, 1949, suggested an extensive lesion in the temporal lobe of the right hemisphere; the possibility of multiple lesions could not be excluded. Ventriculography showed mildly dilated ventricles with an unexplained shift of the ventricular system to the left. An arteriogram showed no displacement of the anterior or middle cerebral vessels. No diagnosis could be made. On October 24, 1949, an exploration of the right frontotemporal lobes was carried out with a biopsy of the right temporal lobe (Dr. Charles Wilson).

At operation the surface of the right temporal lobe and sylvian notch appeared normal. On palpation the cortex was more firm than normal. Particularly in the temporal region, the surface of the brain felt hard. On introducing the exploring needle, resistance was encountered on exploring in every direction in the temporal lobe; no area of focal softening or cyst formation was encountered. Less resistance was found in the posteroinferior part of the frontal lobe. Cortex was removed from the temporal lobe; no definite abnormality was found but the subcortical tissue was unusually tough. Several small pieces of subcortical tissue were removed.

The removed tissue which was studied in the Department of Neuropathology (Dr. Scharenberg) was reported to show diffuse gliosis which was considered to represent radiation damage.

Postoperatively the patient was placed on dilantin and phenobarbital. He returned for re-examination on December 8, 1949, with history of no convulsions and gradual improvement of the hemiparesis. He had difficulty in reading and showed instability on walking. He was slow to understand questions but responded fairly intelligently. The right eye was fixed in the forward direction, bilateral optic atrophy was present, right facial peripheral paralysis

persisted and strength was good in all extremities.

The patient returned again on January 11, 1950, with a history of five or six abortive grand mal episodes since the last visit. Walking had improved as had the use of the hands. During the course of the visit, the neurosurgeon noted ten to fifteen petit mal seizures of which the parents were unaware. On the next visit, one month later, it was reported that he was given to outbursts of temper and sulking and that he had attempted to strangle his brother on one occasion. His vision was fair for gross objects. He was definitely slower in his movements and quite ataxic. Both arms and legs were very strong.

The last follow-up information, dated July 17, 1951, obtained from a letter from his parents, indicated that he was getting along pretty well. Convulsions were still occurring, sometimes twice weekly; at other times a whole month would elapse with none. He still swayed on walking.

Summary. Subtotal surgical removal of medulloblastoma with postoperative roentgen treatment. Alive $9\frac{1}{2}$ years after the radiation treatment. Convulsions first occurred $7\frac{1}{2}$ years after treatment and have been present for two years. Exploratory operation, seven years and nine months after irradiation, revealed an abnormally firm brain which microscopically showed diffuse gliosis.

Case v. R. E. D. (No. 533880), male, aged four, admitted September 23, 1943, with history of vomiting for one month becoming projectile in character five days before admission. Gait became unsteady and staggering one week and vertigo developed two days before admission. Examination showed slight papilledema, unsteady gait and poor adiadochokinesia bilaterally. Skull roentgenograms showed no definite abnormality but ventriculography disclosed moderate internal hydrocephalus; the aqueduct and fourth ventricle were not seen. On September 27, 1943, a suboccipital craniectomy with gross total removal of a cerebellar tumor was carried out (Dr. Carl F. List).

At operation, when the dura over the cerebellar hemispheres was opened, a grayish, relatively avascular surface tumor which filled the entire posterior cistern was seen. The tumor infiltrated into both hemispheres and occupied the entire lower half of the vermis. In addition, there was a large extension into the spinal canal. These portions were removed as well as another piece which arose from the roof of the fourth ventricle and had grown far laterally into the left hemisphere, as well as a process of the tumor which, growing into the left hemisphere, as well as a process of the tumor which, growing into the fourth ventricle, had practically plugged this cavity. All visible tumor tissue appeared to have been removed.

Microscopic examination of the tumor tissue carried out in the Department of Neuropathology was reported as medulloblastoma (Dr. N. Malamud).

The child did well postoperatively and roentgen treatment was started on October 7, 1943, and completed on November 8, 1943. Vomiting occurred on two occasions.

Examination on June 20, 1944, showed some return of hair on the scalp, normal fundi and no cerebellar signs except minimal ataxia. There were no complaints. The parents reported that the child played normally. This situation persisted throughout the subsequent years, including 1951. The boy developed normally; at twelve years of age he weighed $105\frac{1}{2}$ pounds and was $58\frac{3}{4}$ inches tall. He attended school where he was an honor student, did farm chores, and had complete freedom from headache and vomiting. On November 5, 1951, while playing, he was struck on the posterior part of the head. He did not lose consciousness but was nauseated and vomited and did not feel well for several days; after this he regained his normal status. Examination on November 26, 1951, revealed the scalp hair to be dry and sparse with some alopecia in the occipital region. The occipital skin showed light mottled pigmentation and dryness. Neurological examination was negative; all cerebellar tests were satisfactory. There was no evidence of recurrent neoplasm.

Summary. Gross total removal of medulloblastoma with postoperative roentgen treatment. Alive and well eight years and one month after radiation treatment without physical or mental impairment.

Case vi. G. H. (No. 539313), female, aged thirty-two months, admitted December 31, 1943, with history of intermittent projectile vomiting for two months. On several occasions patient showed evidence of dizziness and im-

balance with a tendency to fall to the right. Only one episode of headache. Physical examination was essentially normal except for bilateral papilledema. Routine skull films showed some sutural separation and a ventriculogram revealed moderate internal hydrocephalus. The fourth ventricle was visualized and was normal in shape and slightly dilated.

On January 3, 1944, a suboccipital craniectomy was performed (Dr. Max M. Peet). The arachnoid over the cisterna magna was greatly thickened and had the appearance of a plastic arachnoiditis. A section of this was removed and the superior portion of the fourth ventricle was explored. No gross tumor was seen within the ventricle.

Microscopic examination of the removed tissue was reported as medulloblastoma (Dr. K. Scharenberg).

Postoperatively considerable nausea and vomiting occurred but the recovery was fairly satisfactory. Roentgen treatment was started on January 11, 1944, and completed on February 11, 1944.

Until October, 1944, the patient was in good health, gained weight, ran about the house, and hair was returning. On October 17 the patient's father, a physician, reported that the patient had convulsions for one-half hour followed by a semicomatose state for one and one-half days. After the semicoma passed she seemed to be in good health. She reportedly received more roentgen treatment but no data on this are available. Through 1945 to 1947, the patient was reported consistently to be in good health and gained weight. Photographs during this period showed a well developed child with a full head of hair. In May, 1949, the mother reported the child to weigh 80 pounds with good memory and intelligence but to have eye trouble, "sometimes cannot see for a moment." In 1950 patient developed epileptic seizures which have continued until the time of the last follow-up information in the first part of 1952.

Summary. Subtotal surgical removal of medulloblastoma with subsequent roentgen treatment. Alive eight years after roentgen treatment but has been having epileptic attacks for at least 3 years.

Case VII. M. V. (No. 564182), female, aged eight, admitted February 15, 1945, with history of slight headache of short duration in October, 1944, with subsequent clumsiness, dizziness and inability to judge distance correctly. Violent frontal headache appeared in December, associated with forceful vomiting lasting for five to six days. Three days before admission patient suffered severe headache accompanied by projectile vomiting, staggering gait, anorexia and increased irritability. Examination disclosed questionable nystagmus in vertical plane, bilateral papilledema, retinal hemorrhages, past pointing on finger-nose test on left, slight vagus voice and an unsteady, staggering gait. Ventriculography carried out on February 23, 1945, disclosed evidence of a midline cerebellar tumor. On February 24, 1945, suboccipital craniectomy was performed with subtotal excision of a tumor (Dr. Max M. Peet).

At operation, following incision of the vermis, a grayish, partially necrotic infiltrating mass was disclosed, extending into both cerebellar hemispheres. After total excision from the hemispheres and the vermis, the tumor was found to fill completely the fourth ventricle, passing through the aqueduct (which was dilated to the diameter of a cigarette) into the third ventricle; this was removed in one piece. However the tumor invaded the left lateral wall and the floor of the fourth ventricle and this could not be removed.

On the removed tissue, a pathological diagnosis of medulloblastoma was made (Dr. K. Scharenberg).

The postoperative course was not unusual and roentgen treatment was started on March 7, 1945, and completed on April 10, 1945. The patient's condition improved during the period of irradiation; she vomited small amounts on most days. The voice returned to normal. The patient was discharged on April 10, 1945.

One month later, her physician reported occasional vomiting and considerable difficulty in walking, but six months after discharge examination by the same physician disclosed normal fundi, fairly steady gait with improvement in general condition. In 1947 she was reported to be in good health with some unsteadiness on walking. Mentally she seemed to be normal and her hair had returned. Reports in 1949, 1950 and early in 1951 stated the patient to be hale and hearty, that she had done well in school and that her only abnormality was a slight unsteadiness on walking. It was reported that the patient learned to write left handed instead of right handed which was normal for her. The last follow-up information was dated July

6, 1951, and stated that her condition was unchanged except for questionable increased instability at times.

Summary. Subtotal surgical removal of medulloblastoma with postoperative roentgen treatment. Alive and well $6\frac{1}{3}$ years after radiation treatment.

DISCUSSION

In the previous report it was considered that the evidence suggested that medulloblastoma of the cerebellum may be a curable neoplasm in contrast to the generally accepted opinion that it was an inevitably fatal disease. Four patients had survived seventy to ninety-two months after treatment without evidence of recurrence and 3 were in good condition. Furthermore, it was apparent that the survival was due to the radiation treatment since no substantiated report could be found of a patient living and well more than three years after treatment when surgical removal was the sole therapy. With the passage of time, the evidence for the radiocurability of this tumor has become convincing. All of the 7 survivors are still alive, $6\frac{1}{3}$ to $11\frac{1}{12}$ years after treatment.

On the other hand, the picture in respect to the late physical and mental status of the survivors has been disappointing. Case I has shown progressive physical and mental deterioration with convulsions for almost seven years. Although alive $10\frac{3}{4}$ years after irradiation, the patient is a completely helpless deteriorated individual. The continued existence for almost seven years after the the first manifestation (convulsions) of serious brain abnormality effectively excludes recurrent medulloblastoma as its cause. The conclusion is drawn that the tumor had been eradicated but brain damage has developed, presumably due to the radiation treatment.

Case IV likewise is an example of apparent cure of the neoplasm but with brain damage which first became clinically manifest (convulsion) $7\frac{1}{2}$ years after treatment. At the second operation gross examination of the brain, limited to the temporal and posterior part of the frontal lobes on the right, revealed abnormally firm tissue and microscopic examination showed diffuse gliosis. The brain changes are believed to represent radiation damage. The patient is living $1\frac{3}{4}$ years after this exploratory operation and although he still has grand and petit mal seizures, only partially controlled by medication, the hemiparesis present preoperatively has cleared completely. The possibility of recurrent medulloblastoma appears remote. In this patient, as in Case I, the surgical removal of the tumor was incomplete.

A similar situation is seen in Case VI (tumor incompletely removed) now alive eight years after irradiation with epileptic seizures for probably three years. Assessment of the final status of Case II is less clear with respect to brain damage, but the fact that the patient is alive at $11\frac{1}{12}$ years points to complete eradication of the neoplasm. The occurrence of an acute cerebral episode with hemiparesis (reminiscent of the episode in Case IV) at $7\frac{1}{2}$ years after irradiation is highly suggestive of brain damage. Thus in 3 of the survivors evidence of brain damage is clearly present; in the fourth it is probable.

Of the remaining 3 patients, in good health at time of last follow-up, one is $6\frac{1}{3}$ years postirradiation. In view of the fact that Case IV remained in good condition for $7\frac{1}{2}$ years after treatment before manifesting convulsions, this patient has not been followed long enough to determine the final status. Cases III and V at $9\frac{1}{6}$ and $8\frac{1}{12}$ yeas after irradiation and in good condition apparently are candidates for a good result but the possibility of development of clinical evidence of brain damage at a future date cannot be excluded. Final evaluation awaits further follow-up.

In preparing the report of 1949, an extensive review of the literature was made covering the years 1925 to 1948.[4] the results of treatment of this disease were found to be uniformly depressing. When Bailey and Cushing first segregated this neoplasm from the general group of gliomas, the

average life expectancy for patients treated by operation alone was about seven months. With the addition of radiation treatment and improvement in irradiation techniques, average survival was increased to two or three years. Reports of patients with longer survival were found, approximately 27 surviving more than three years. Twelve of these apparently were alive three to nine years after treatment, presumably without clinical evidence of disease. It proved impossible to determine the total number of patients from which the 27 came. In general, the literature dealt with prolongation, rather than with the saving, of life in patients with this tumor.

The available literature since 1948 is limited and, with one exception, the picture of depressingly poor results persists. Engeset[1] reported 4 patients in 1949, 3 dying less than three years after operation and irradiation and 1 patient, nineteen years of age at time of treatment, living at 11½ years, almost blind (this was her visual status prior to treatment). Pennybacker,[7] in 1950, listed 1 survivor (apparently out of 57 patients) alive and well seven years after treatment. This patient was thirty-five years of age when treated. Spitz, Shenkin and Grant[8] reported the outlook to be more favorable in adults with this disease than in youngsters (note the ages at time of treatment of the survivors in our series: 32 months, 4, 8, 9, 12, 14, and 18 years). Freid and Davidoff[2] in 1951 reported on 6 patients with 3 alive at 1⅔, 3½ and 4 1/12 years. The last patient was twenty-four years old at time of treatment and was in good health at last follow-up. In 1951 Grant and Sayers[3] reported 50 cases of medulloblastoma with 3 survivors for more than three years. One, ten years of age at time of operation, was alive eleven years later. One died of recurrence seven years after operation of recurrent neoplasm (this patient was 16 years old when operated upon). The third, aged fifteen years when operated upon, died eleven years later, probably of recurrence. All their patients received postoperative roentgen treatment.

The exception to the reported poor treatment results is found in the statistical report by Paterson, Tod and Russell[5] on the results of radiation treatment at their institution. Ten patients with medulloblastoma are listed. These were treated during 1940-1944 and 5 were known to be alive five years later; 2 of these were stated to be "disabled." The ages at time of treatment are not given but from the brief discusion accompanying the tabulation it is inferred that all or nearly all were young persons. Likewise, apparently the tumors were located in the cerebellum, although no specific statement is made. The irradiation technique developed at their institution[8] consists of a three field arrangement in which one large field posteriorly covers the head and spine down to the second sacral vertebra, using a focus skin distance of 120–150 cm. Two anterior oblique fields are used to raise the dose in the anterior part of the brain. The statement is made that the minimum dose to the cerebrospinal system should be 3,500 r in five weeks, with the maximum skin dose kept under 5,000 r. This technique was started in the middle of the reported period of 1940 to 1944.

On theoretical grounds, our technique employing high daily doses, delivering the total dose per segment in the short time of seven to ten days, is subject to criticism. Estimation of the tissue dose received by these patients is difficult but it is probably of the order of 2,500 r in the midline of the posterior cranial fossa. General clinical experience indicates that one may anticipate radiation damage when high daily doses and short treatment times are utilized, as in the patients reported here. This technique has been abandoned in favor of a protracted course of treatment, delivering to the tumor area over a period of fifty-five to sixty-five days a dose of the order of 5,000 to 6,000 r. Whether this method will prove equally efficacious in eradicating the neoplasm cannot be predicted. Only a few patients have been treated in this manner and the interval after treatment is much

too short to permit any evaluation. If survivors are obtained, it will be years before it can be determined whether late brain damage is produced. The late status of the Paterson cases will be of great interest in this respect.

SUMMARY

From 1938 to 1946 inclusive, 26 patients with medullobastoma of the cerebellum were treated by surgery and vigorous postoperative irradiation. Seven patients are alive from 6⅓ to 11 1/12 years after the radiation treatment (a survival rate of 26.9 per cent). Three patients definitely exhibit manifestations of brain damage: one is a helpless individual, the other two have a convulsive disorder. In a fourth patient it is probable that brain damage was the cause of an acute cerebral episode with hemiplegia, from which, however, the patient recovered. Clinical manifestation of brain damage first appeared as late as 7½ years after treatment. Three patients are well without evidence of brain disturbance at 6⅓, 8 1/12 and 9½ years after irradiation.

The evidence suggests that medulloblastoma of the cerebellum is a radiocurable neoplasm. The high daily dose technique employed in the treatment of this series of patients has been abandoned in favor of more protracted irradiation.

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RADIATION TREATMENT OF CARCINOMA OF THE CORPUS UTERI*

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THIS study was undertaken to ascertain, if possible, any direct relationship between the clinical results of radiation therapy and the dose delivered in the treatment of carcinoma of the uterine corpus. Previous studies on an experimental basis have indicated that an improved dosage distribution might be obtained by technical improvement in the means of intrauterine radium implantation.[5,6] Clinical studies have indicated improved results from the use of such methods by several authors.[1,7] That this improvement is due to more effective radiation dosage is a logical conclusion. However, direct dependence of outcome upon dosage is difficult to demonstrate in clinical material. Demonstration of such a dependence is especially difficult in the consideration of adenocarcinoma of the corpus uteri. Here there are many clinical variables which may influence not only the technique of radiation therapy, but also the clinical outcome itself. A conclusion that radiation dosage, delivered, is of prime importance in clinical success or failure must be carefully evaluated.

MATERIAL

The material used in this study includes some 248 patients with carcinoma of the uterine corpus treated at the Los Angeles Tumor Institute between the years 1933 and 1951, inclusive. These patients include only those whose treatment was initiated, and the great proportion of them were treated by radiation measures alone. In recent years postirradiation hysterectomy has been performed in patients suitable for this procedure. Formerly, the material included many patients considered technically or constitutionally inoperable, but there were also those who refused operation or who were referred for nonoperative treatment. This group of patients, then, provides an ideal sample for the study of the effectiveness of radiation therapy in this disease.

TECHNIQUE OF TREATMENT

The technique of radiation treatment has included intrauterine radium and external roentgen irradiation. In the previous years the plan was to use two or more radium implantations at two or three week intervals. These included gold intrauterine tandems containing two 25 mg. tubes. These tandems were of 5.5 cm. length and 0.5 cm. diameter, with the filter equivalent to 1 mm. gold. In addition, intravaginal bombs were applied to the portio of the cervix and the fornices. These also contained three 25 mg. tubes arranged in parallel, with an equivalent filter of 2 mm. of platinum.

In recent years multiple capsule implantations have been performed. Three to seven individual 10 mg. sources have been packed into the fundus and the cor-

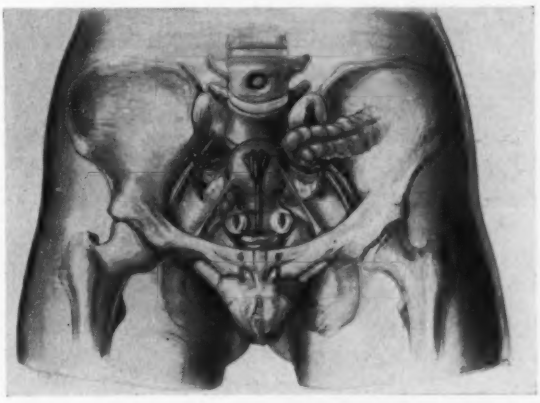

FIG. 1

* From the Los Angeles Tumor Institute. Presented at the Fifty-third Annual Meeting, American Roentgen Ray Society, Houston, Texas, Sept. 23–26, 1952.

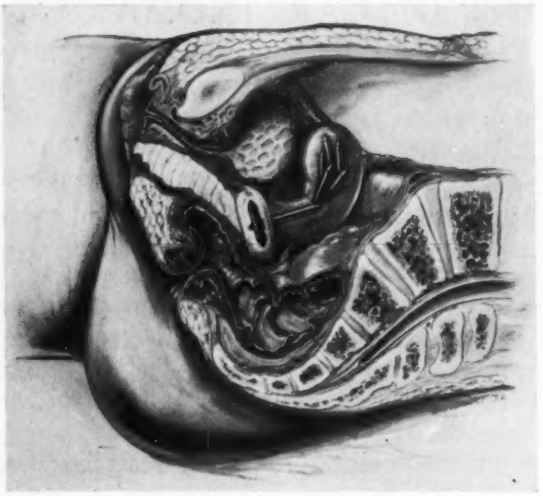

FIG. 2

pus, with a short tandem of 20 mg. in the cervical canal. In conjunction with these sources, vaginal implantations have been done in sponge rubber colpostats or in plastic ovoids, utilizing a 25 mg. source in each vaginal fornix. The over-all length of each single capsule is 2.3 cm. and the filter 1.37 mm. of platinum. At least two implantations have been used, at two to three week intervals. Treatment times have been from twenty-four to forty-eight hours, usually about thirty hours. Milligram hour exposures range from 6,000 to 8,000—usually about 7,000 milligram hours from all sources. Roentgenograms are taken during the course of treatment to ascertain the distribution of the radium.

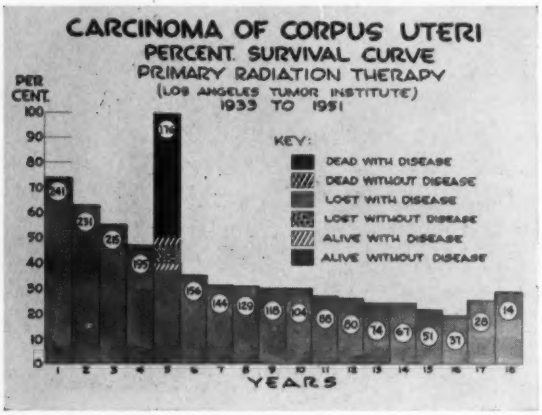

FIG. 3

External roentgen irradiation was given if the patient was not to have a hysterectomy. Physical factors were as follows: four pelvic portals, 10 by 15 cm., 150 r (in air) to each of two portals daily, for totals of about 1,800 to 2,100 r (air) each, 500 kv., 4 ma., 1 mm. lead equivalent filter, 6 mm. Cu half-value layer. In patients who are to be operated upon, external roentgen irradiation is omitted. Operation is performed four to six weeks after the last radium implantation, depending upon the patient's general condition and reaction to the treatment.

RESULTS OF TREATMENT

The results of treatment in this group of patients are shown by the survival curve in Figure 3. This family of bar graphs indicates, in percentages, the number of patients known to be alive after the initiation of their treatment, in years. The shape of the curve is the usual one, although the values are low. At the five-year point the bar graph shows the status at that time for those patients eligible for follow-up. Only 36 per cent are known to be alive without disease, and 57 per cent includes those known to have died with disease; alive with disease, or lost, with disease. As has been stated before, the clinical material is not of the most favorable type, but, admittedly, these over-all end results are not laudatory. These results are similar to those obtained by Heyman during the period in which he used a similar method of treatment.[2,3] His improvement in results by the introduction of multiple capsule method of radium implantation was so great that he has been satisfied to treat all patients with radiation alone and operate only upon those who have shown clinical signs of residual or recurrence. The increase in his over-all survival rate must be due to an increase in actual doses delivered.

PELVIC DOSAGE AND RESULTS

In order to calculate the dosage delivered to the pelvis, an arbitrary point, designated as point C, has been chosen for the point of

comparison. This point lies 5 cm. up from the external os and 2.5 cm. lateral to the midline. It represents the periphery of the uterine corpus in a normal uterus, and is fixed in its relation to the broad ligament. If the uterus is enlarged, this fixed point still bears a relationship to the center of the endometrial cavity at the periphery of the uterine corpus. It was thought that the radiation falling on this point would be of significance in relation to the possible extent of the primary tumor. For the purposes of this study, the charts of the patients were reviewed and calculations were made as to the radiation delivered to point C, from the description of the physical factors of radiation and from the depth and size of the uterus.

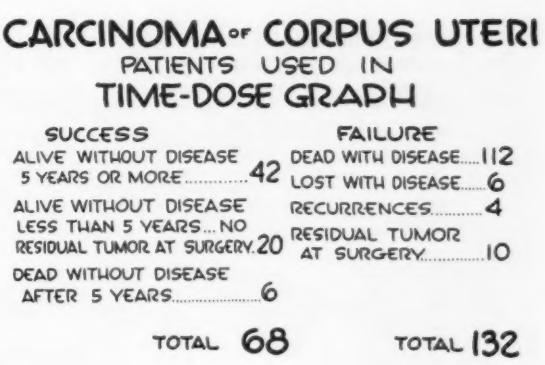
CARCINOMA OF CORPUS UTERI
PATIENTS USED IN
TIME-DOSE GRAPH
SUCCESS
ALIVE WITHOUT DISEASE 5 YEARS OR MORE 42
ALIVE WITHOUT DISEASE LESS THAN 5 YEARS... NO RESIDUAL TUMOR AT SURGERY 20
DEAD WITHOUT DISEASE AFTER 5 YEARS 6
TOTAL 68
FAILURE
DEAD WITH DISEASE 112
LOST WITH DISEASE 6
RECURRENCES 4
RESIDUAL TUMOR AT SURGERY 10
TOTAL 132

Fig. 4

Significance of Other Factors

In ascertaining the clinical success or failure of the primary radiation treatment, criteria were used which vary somewhat from the usual survival criteria. It was

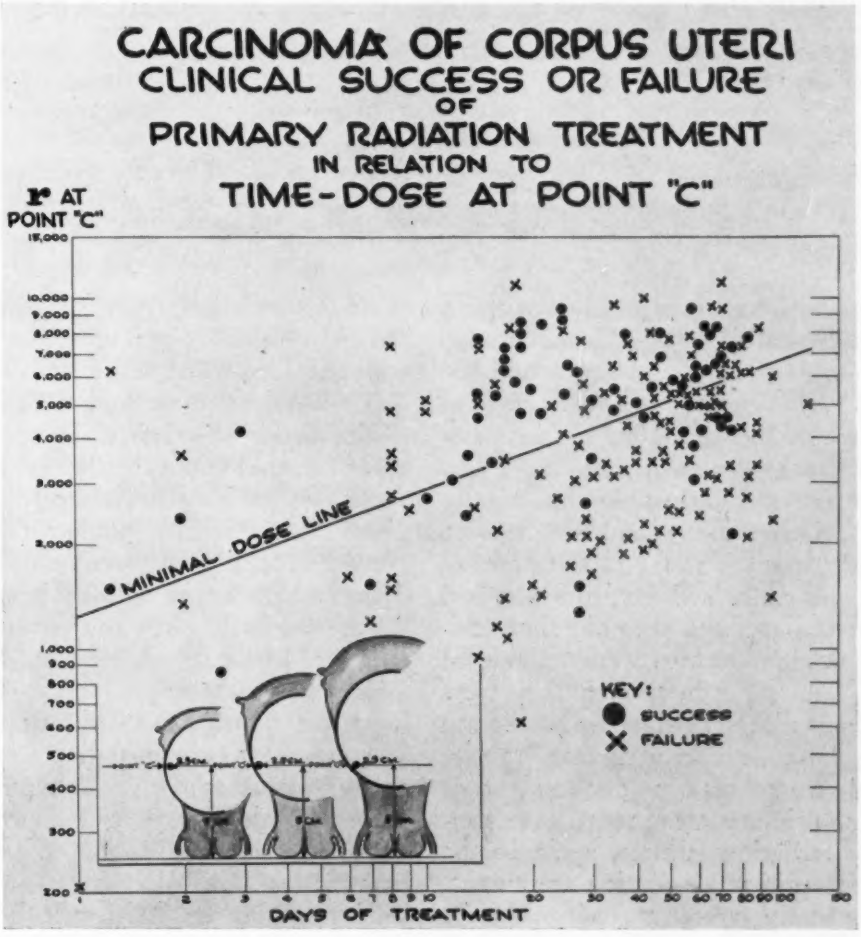

Fig. 5

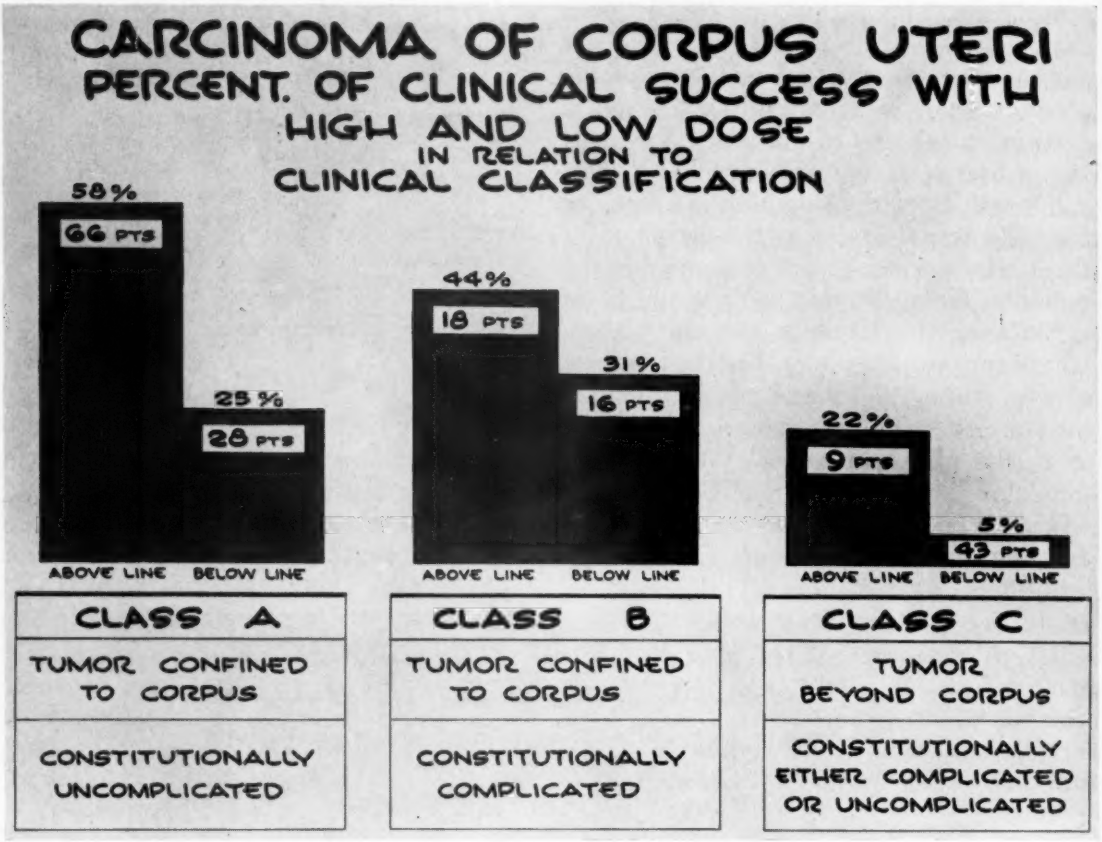

FIG. 6

necessary to exclude patients lost without disease and dead from intercurrent causes in less than five years, as these would not give us information on the effectiveness of the treatment. Patients alive without evidence of disease less than five years, who had hysterectomy, and whose tissues indicated no evidence of residual tumor, were considered successes as far as the primary radiation was concerned. Patients who had had hysterectomy, and who did show evidence of residual tumor, were considered radiation failures, even though they were alive without disease. All patients who are known to have died with disease, or who developed recurrences from one to eighteen years after primary treatment, were considered as radiation failures, again in the light of the primary radiation treatment. Since this study concerns itself with the effectiveness of the radiation therapy, these criteria were considered to yield the most information from all the patients treated. Figure 5 represents a time-dose spot graph on which these clinical successes and failures were marked for 200 patients available for this study. It must be emphasized that clinical selection and technical factors have arbitrated the dosages given, rather than a random distribution. However, from these points a line might be drawn which would be considered minimal dosage line. Although the data seemed to indicate where the line should fall, the slope was chosen to conform to that found in other time-dose relationship studies.[4] There are not enough patients nor a great enough variation in doses delivered to allow for the projection of this line upon the data alone. It is reasonable to assume that biologic reactions of other tissues may be used to guide us. With the line drawn, there seems to be a definite relationship between clinical success and dose delivered.

Above the line some 72 per cent of the successes occur and below it 61 per cent of the failures. Of 100 patients receiving more than minimal dosage, 49 per cent were successful; and of the 100 patients receiving less than minimal dosage, 19 per cent were successful. This percentage difference may be considered very significant, being less than the 1 per cent level of statistical significance. This was more marked than one had hoped to find and seemed to indicate a definite dependence of clinical outcome upon dosage. However, as stated earlier, the significance of this importance of dosage must be tested against other factors which could influence prognosis.

In order to make such a test, the patients were divided into three classes according to clinical status. Class A patients are those in whom the disease appears, on clinical examination, to be localized in the body of the uterus, and who have no constitutional complications, such as advanced age, obesity, hypertension, diabetes, etc. Class B patients include those who do have one or more constitutional complications but who still appear to have tumors localized in the corpus uteri. Class C designates patients in whom the disease has spread beyond the corpus on clinical examination.

Within each of these groups there is a greater percentage of successful treatments with high dosage than with doses beneath the minimal dose line. These differences are of statistical significance in the Class A group, but significance is not evident in the Class B and Class C patients because of the paucity of numbers in each subcategory. In any case, it would appear that the dose delivered is still of utmost importance despite the clinical condition of the patient by these criteria.

SUMMARY

From the experience gained in the treatment of 248 patients with carcinoma of the corpus uteri primarily by radiation measures, an attempt has been made to judge the significance of dosage in relation to the outcome. The studies indicate that the amount of radiation, in roentgens, delivered to an arbitrary fixed point in the proximal parametrium has a definite bearing on the clinical success or failure of the treatment. If this be true, it is important to use techniques of radiation therapy which will allow for the delivery of high doses to the proximal parametrium by increasing the uniformity of dosage distribution.

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DISCUSSION

DR. JOHN A. WALL, Houston, Texas. The authors are to be commended on their evaluation of a large series of patients with endometrial carcinoma, particularly with reference to the status of radiation treatment of this disease. Gynecologists are anxious to prove that surgery is paramount in the treatment. Current surgical literature is again showing evidence of dissatisfaction with irradiation either before or after hysterectomy in endometrial cancer. This is probably due to a lack of understanding

of the principles involved in proper dosimetry and to the wide divergence of recommended therapy. Therefore, such studies as we have had presented today are most important and timely.

There are many clinical variables which make standardization of treatment impossible in this particular neoplasm. However, a knowledge of the complementary contributions to be derived from surgery and irradiation must be thoroughly understood by the gynecologist as well as the radiotherapist if effective individualization of treatment can be expected to eventuate in a successful therapeutic result. Our preference is for thorough irradiation of the uterine corpus and vagina by means of multiple radium sources, as described by Heyman. This treatment precedes total abdominal hysterectomy and bilateral salpingo-oophorectomy four to six weeks later.

The authors' material is rather difficult to evaluate because of the different techniques utilized. Results would seem better correlated with the isodose surfaces resulting from each radium pattern, rather than the dose to a fixed point. The dose to the irradiated volume of tissue would probably be more properly assessed by such a study. It would be interesting to know the results where the different techniques, such as the tandem with the vaginal bomb, Heyman's packing plus ovoids or rubber colpostat, or the tandem and Heyman's uterine packing plus external irradiation have been employed in irradiating the uterus.

The advisability of a single fixed point (point C) may be questioned as a means of evaluation of therapeutic results in adenocarcinoma of the endometrium. The dose at point C should be affected markedly by variations in the position, shape, and size of the uterus with respect to variations in the radium pattern. The impossibility of determining clinically a fixed point with respect to the distance of that point from the tumor under consideration limits the practicability of the use of such a fixed point of reference.

It would seem more probable to presume that the apparent improvement achieved by the Heyman packing technique is due to the favorable radium distribution and consequently a more effective shape of the isodose curve, and not to improvement as a result of an increased dose delivered to the fixed point C. Heyman has reported 61.9 per cent relative cure rate in 459 patients treated in 1934 to 1941, and his technique is generally accepted as the best for radium treatment of this neoplasm. A cancerocidal dose is delivered to a wider block of tissue by virtue of the distribution of multiple radium sources and consequently a better chance of a uniform lethal dose to the whole tumor, the extent of which cannot be determined by clinical examination alone.

We have not found in our experience that roentgen treatment of significant proportion directed to the parametrial extension of tumor is possible. Adequate dosage to the lymph nodes is highly improbable in the typically obese patient with endometrial carcinoma. The betatron and cobalt 60 irradiation may alter these conclusions. But to date we feel it is illogical to expect effective dosage to the parametrium and the primary and secondary retroperitoneal lymph nodes by means of the conventional roentgen therapy and even less effect on the tumor itself inside the uterine cavity.

As a gynecologist, I would like to beg your indulgence as I deviate somewhat from the general theme of the paper presented by Dr. Costolow to emphasize the need for hysterectomy wherever possible following radium therapy to the uterus and vagina. Endometrial cancer characteristically extends downward to the endocervix and portiovaginalis of the cervix, and this most frequently is a manifestation of a late stage of the disease and *can be detected clinically*. However, extension into the endosalpinx is of more importance as far as the indications for hysterectomy are concerned. The association of carcinoma of the fallopian tube, either primary or metastatic, with cancer of the endometrium is a hazard and may be easily missed if one takes pelvic examination and fractional curettage as conclusive evidence that the disease is limited to the uterine cavity, and treatment as such is carried out. Therapy delivered to the uterine corpus will prove grossly inadequate as a method of sterilization of tumor, either primary or metastatic, in the fallopian tube. Granulosa cell tumors and certain other feminizing tumors may, as another example, in themselves prove to be vicious malignancies, and the frequency with which such dual involvement is associated with adenocarcinoma of the endometrium is well recognized. These lesions in the tubes and ovaries will be missed unless surgical exploration proves their presence, and one will erroneously charge a failure to radiotherapy.

Likewise, one should also exclude cases where less than four sources of 10 mg. each are accommodated by the uterus since such cases cannot be considered as having had an adequate dose to the tumor in the uterus. It is all the more imperative to do hysterectomy on these patients if cure of the endometrial cancer is to be achieved.

Dr. Costolow (closing). I certainly wish to thank Dr. Wall for his very able discussion of our paper. He emphasized some of the points which we attempted to bring out.

This study was undertaken to ascertain, if possible, any direct relationship between the clinical results of radiation therapy and the doses delivered in the treatment of carcinoma of the corpus uteri. With the multiple capsule technique we find that about 80 per cent of the cases at surgery do not show residual carcinoma in the fundus. With the old tandem method, about 44 per cent of those who went to surgery had residual disease.

We did not discuss surgery versus radiation therapy. It is our belief (and we do it routinely) that carcinoma of the fundus without constitutional complications should have thorough radium treatment by means of multiple capsules, followed by total hysterectomy. We believe that is the treatment of choice.

INTEGRAL ROENTGEN THERAPY FOR CARCINOMA OF THE CERVIX UTERI*†

By J. A. del REGATO, M.D.
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THE classical combination of external pelvic roentgen therapy and intracavitary curie therapy has long proved capable of controlling a good number of cases of carcinoma of the cervix. But the results of this combined treatment, as practiced by the different workers and institutions, present us with an uncomfortably wide range of effectiveness (Heyman).

A fairly large proportion of failures are due to extension of the tumor beyond the limits of the pelvis and consequently beyond the sphere of curability by any present available means. But a number of failures may be prevented by better irradiation. Efforts to improve results through the perfecting of radium applicators and techniques have met with relative success (Ernst). Standardization of dosage at points Y or Z has met with unquestionably academic interest (Tod) but little practical consequence, for the idea of dosage cannot be dissected from other factors, such as the variations in intensity of delivery, which play an important part in its effectiveness and interfere with standardization. The pathological condition modifies the anatomy of the pelvis to the extent that theoretical points are of no value and the calculations of radium dosage greatly inaccurate. Few have applied themselves to an improvement of the external pelvic irradiation (Fletcher).

The successful irradiation of radiocurable malignant tumors requires the administration of a dose of radiation capable of sterilizing the growth at the extreme points of its extension. In general, the total dose administered is an empiric maximum governed by the possible hazards at a given point rather than by any knowledge of optimum biologic effect. There is experimental and clinical evidence showing the advantage of a protracted delivery of that total dose, only practical considerations have tended to limit the length of protraction; the daily dose is of secondary importance to the accumulation of the necessary total.

In our opinion, an ideal irradiation of malignant tumors should be carried out according to the following principles:

(1) All potential areas of involvement should be irradiated frequently, particularly when the daily dose absorbed is small.

(2) The total dose should be as homogeneously distributed as it is physically practicable, throughout the potential area of involvement.

(3) The dose should be homogeneously distributed in time as it is in space to avoid waste, and to facilitate reproducibility of treatments.

(4) The treatments should be protracted for as long as it is necessary to administer an efficient dose with a minimum of risk.

We have attempted to put these principles in practice in the treatment of carcinoma of the cervix in a trial of *integral* roentgen therapy. As a consequence, we have chosen to utilize external pelvic irradiation to a maximum degree permissible with our equipment. We use six fields, 8 by 12 cm. in diameter; we do not shield the midline and we irradiate two opposed fields daily in an effort to include all of the tumor in our daily treatments. Unless the tumor has an equal extension on both sides, the beams of radiation are directed from all portals of entry in the direction of the most affected side, crossing the midline deliberately. Our treatments were pro-

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† Presented at the Fifty-third Annual Meeting, American Roentgen Ray Society, Houston, Texas, Sept. 23–26, 1952.

TABLE I

CARCINOMA OF THE CERVIX UTERI
External Roentgen Therapy Plus Transvaginal Roentgen Therapy
1943–1946

	Number of Patients	Died of Intercurrent Diseases before 5 Years	Died of Cancer[5]	Lost to View	Well 5 Years or More	5 Year Cure Rate
Stage I	25[1]	3	8	0	14	56%
Stage II	65[2]	6	35	1	23	35%
Stage III	51[3]	5	30	0	16	31%
Stage IV	50[4]	1	41	1	7	14%
TOTAL	191	15	114	2	60	31%

[1] Excluded: a patient treated by hysterectomy.
[2] Excluded: a patient treated by radium and 2 who received no treatment.
[3] None excluded. Three patients had external irradiation only.
[4] Excluded: 3 patients who had no treatment; 2 who died during the course of treatment, and 1 treated by radium. Included are 8 cases who had external irradiation only.
[5] Or under circumstances not permitting an assurance to the contrary.

tracted over a period of eight weeks; the daily dose received by some parts of the tumor was small, though frequent. The ideal homogeneity of distribution of the total dose is not, of course, possible. But by eliminating the use of radium we avoid the overdosage at the midline; and since there is no fear of "adding insult to injury" we can use the external irradiation to greater advantage, raising the dose at the lateral aspects of the pelvis (Regato). We add transvaginal roentgen therapy merely for assurance of sterilization of the primary focus; but it is quite likely that the transvaginal irradiation could be eliminated if the same principles and procedure were to be adopted with the use of higher voltages.

We are presenting today the results of this approach to the treatment of 191 consecutive cases of carcinoma of the cervix uteri admitted to the Ellis Fischel Cancer Hospital from 1943 to 1946. The external irradiation was administered in approximately eight weeks with 220 kv. equipment; this was followed by transvaginal roentgen therapy in twelve days with 110 to 140 kv. Included in our statistics are 11 patients who received external irradiation only, because of their advanced condition. But we have eliminated from our calculations a total of 10 additional patients: an early Stage I case which was treated by surgery, 2 Stage II patients who refused to be treated, and another one who was treated with radium, 3 Stage IV patients who received no treatment in view of their terminal condition, 2 others who died during the course of external irradiation and still another Stage IV case which was treated with radium. Sixty patients (31 per cent) are well and without evidence of disease after five years. Of 89 patients in Stage III and IV who received complete treatment, 23 (25 per cent) have remained well (Table I).

It will be noted that, taking into consideration the relatively small number of cases, our results in the early cases are not above average. But in the treatment of the more advanced cases, our approach seems to have succeeded in the salvage of an unusual proportion of cases.

Four years ago we lengthened our external pelvic irradiation to a period of ten weeks (400 kv., 3 mm. Cu, and 80 cm.

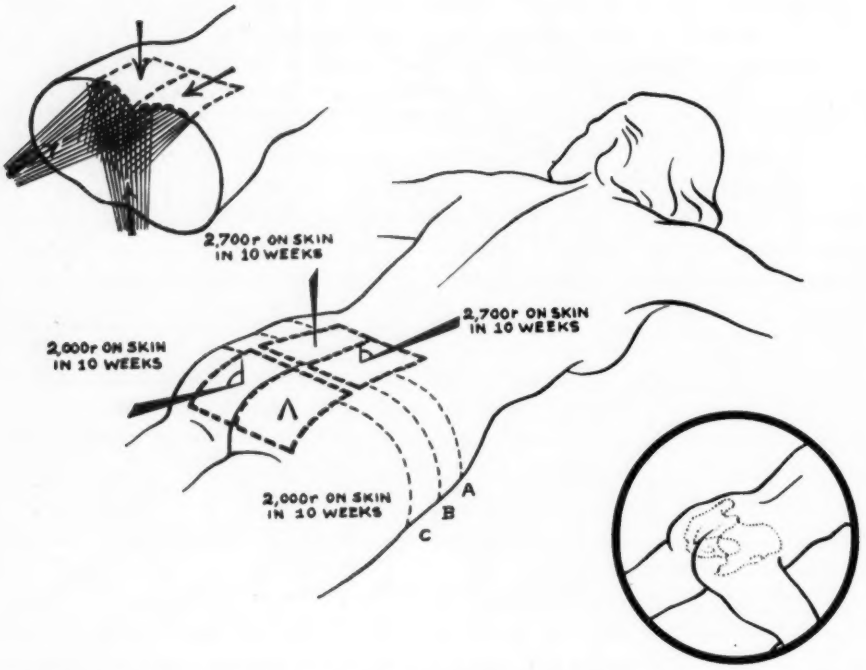

Fig. 1. External roentgen irradiation of a carcinoma of the cervix extending into the left parametrium. Sacral and sciatic fields with beams directed to left side. Circle inset shows position for irradiation of sciatic fields.

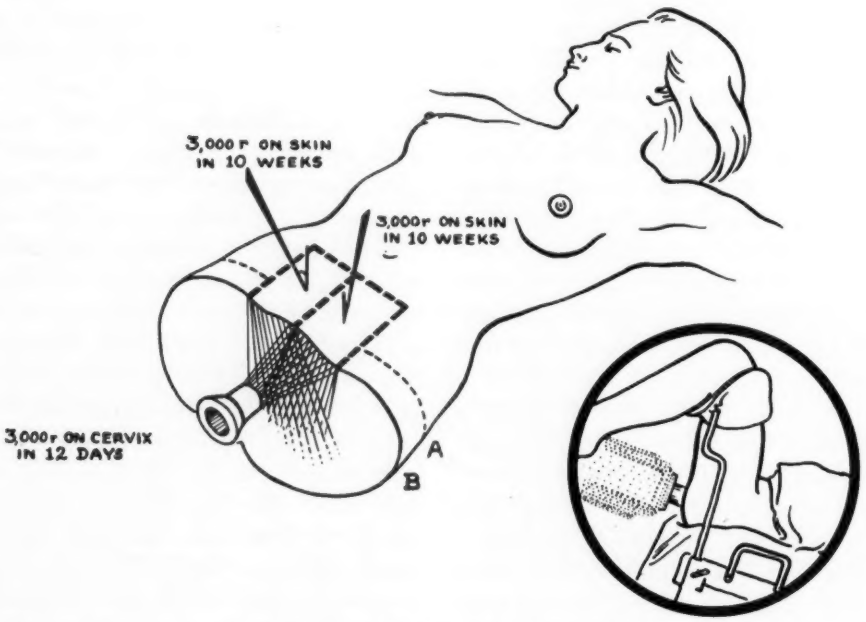

Fig. 2. External roentgen irradiation through anterior and transvaginal fields with concentration of beams toward the left side. Circle inset illustrates position of transvaginal irradiation.

Fig. 3. Phantom of a female pelvis of average dimensions made of 1 cm. slabs of plywood. Note the drawer arrangements to facilitate measurements and the reproduction of pelvic organs on the transverse sections.

target skin distance), and followed this by transvaginal roentgen therapy in an additional period of twelve days (140 kv., 0.5 mm. Cu, 25 cm. distance). Although the skin doses were raised (Fig. 1 and 2), we have eliminated the occurrence of moist radioepidermitis, and bowel reactions have also diminished. There is, of course, no case of systemic reactions of any kind and patients usually gain weight during treatment. The epilation of the pubis is not permanent and after a year has passed the pubic hair often has a normal appearance and distribution.

To study the distribution of radiations throughout the pelvis a phantom reproducing a female pelvis of average dimensions was built of plywood slabs 1 cm. thick; the anatomical structures were drawn on every one of these horizontal sections for easy reference (Fig. 3). Innumerable measurements in depth were taken at various levels while the phantom was irradiated through different fields reproducing our technique in the treatment of unilateral or predominantly unilateral tumors; the doses absorbed at every point from different beams of external irradiation were added, and towards the midline the addition included the figures from transvaginal irradiation. Figures 4, 5 and 6 summarize our findings. The numbers indicate the addition of total doses received at various points through different fields including one transvaginal. The side illustrated is the side of maximum concentration in an asymmetrically irradiated pelvis. It may be observed that whereas homogeneity of irradiation is not obtained, the maximum and minimum total dose received at various points within this section has been brought to a 3:1 ratio. Figure 7 transposes the same information in a frontal plane. For all of this work I am indebted to two of my residents, Dr. William T. Moss and Dr. Orliss Wildermuth; their painstaking task was

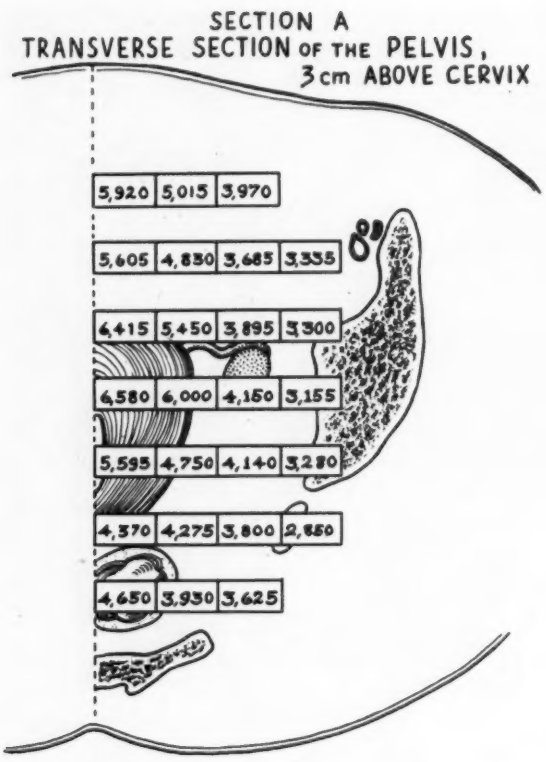

Fig. 4. Side of maximum concentration in an asymmetrically irradiated pelvis. Rectangles correspond to spaces 1 by 2 cm. in diameter. Figures represent number of roentgens received from six external fields and one transvaginal (see Fig. 1 and 2).

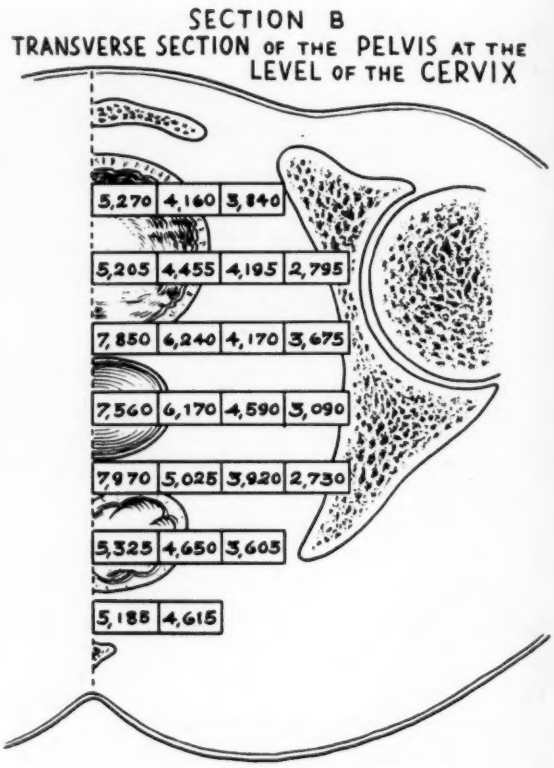

Fig. 5. Side of maximum concentration illustrating total dosages at level of cervix. Note minimum of 2,730 and maximum of 7,970 roentgens within the pelvis in this transverse plane.

surpassed by their unselfish devotion, and for this I am deeply grateful.

More recently we have decided to protract our treatments further, to twelve to fourteen weeks. In advanced cases, where the healing leads to obliteration of the vagina, making a transvaginal irradiation impossible, we have substituted the perineal irradiation (with 400 kv.); the same principle of asymmetric irradiation is followed whenever the tumor is predominantly unilateral on clinical exploration. We are not certain, of course, that protraction to these limits will result in a greater proportion of cases controlled, but without doubt the protracted integral roentgen therapy makes it theoretically possible by permitting a more homogeneous irradiation and a higher dosage with diminished risks.

SUMMARY

1. Integral roentgen therapy (external plus transvaginal) can be utilized to irradiate the entire pelvic contents at dosages that are sufficient to sterilize advanced cases of carcinoma of the cervix uteri.

2. A physical study of the distribution of dosage throughout the pelvis following the author's technique is presented.

3. In 191 consecutive cases the combination of external pelvic and transvaginal roentgen therapy yielded a 31 per cent five year survival rate

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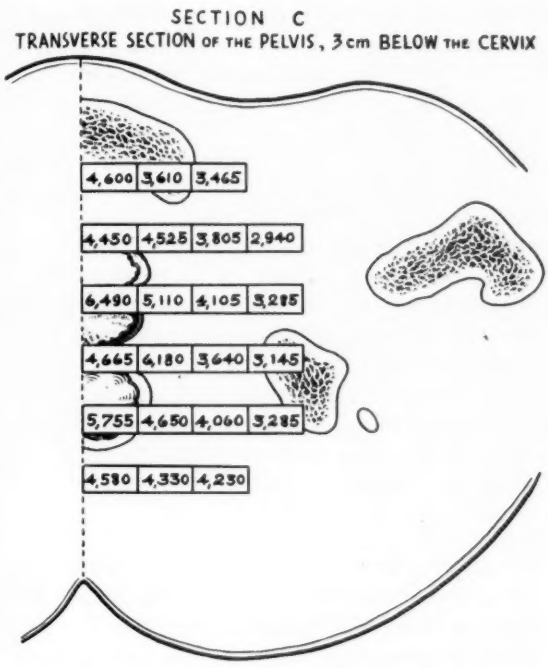

Fig. 6. Same as previous figures; lower section showing total dosage from all fields (see dotted lines of sections A, B, and C in Fig. 1).

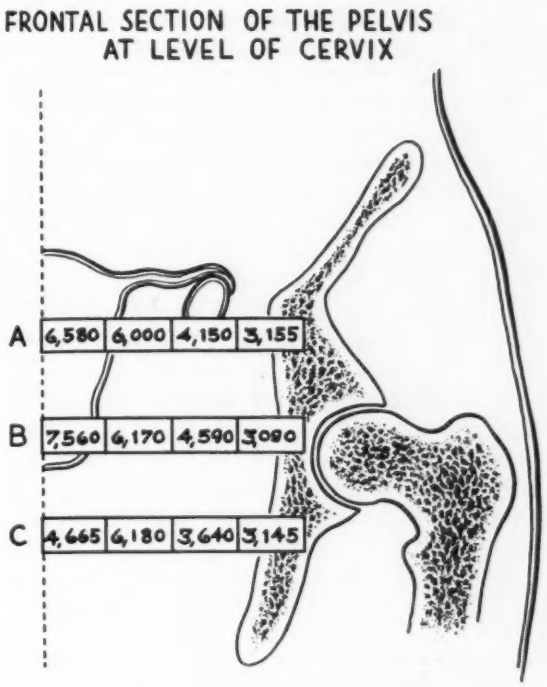

Fig. 7. Side of maximum concentration of an asymmetrically irradiated pelvis. Total dosage at levels A, B, and C of previous figures transposed on a frontal plane (for skin doses see Fig. 1 and 2).

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DISCUSSION

Dr. Edwin C. Ernst, St. Louis, Missouri. Dr. Regato's opening remark is apropos when he quotes Dr. Heyman, of Stockholm, as having made the statement that the results of external pelvic roentgen therapy and intracavitary curie therapy, as practiced by various workers and institutions, present us with an uncomfortably wide range of effectiveness.

I fully agree with this concept in relation to the practice of radium therapy in the past several decades. Relatively few radiation therapy procedures were based on sound physical and even practical clinical criteria, and this includes surgery and even transvaginal roentgen therapy. Therefore, we employed transvaginal roentgen therapy more frequently in the past, as a substitute, than at present.

Fortunately, however, during the past four or five years we observed many evolutionary therapy changes, and improvements in the technical procedures and clinical evaluation concepts of radiation therapy requirements.

We continue to employ the transvaginal method in selected limited groups of recurrent cervical os lesions in which it is very apparent that the radium previously applied was inadequately administered. Especially in large pendulous cervical os lesions, the accurate placement and fixation of loose capsules of radium is extremely hazardous and difficult. It also has a place in selected cervical stump cases.

However, I disagree with Dr. Regato's statement that the standardization of radium dosage at given points in the pelvis in the intracavity procedures has met with only academic interest, and is of little practical value. This may have been true in the past, but today the ra-

dium dosage measurements, with the aid of pencil point crystal scintillation counter technique, both the intensity coefficient and gamma roentgen output per hour at given points in the pelvis, including points A and B, can be estimated in advance and duplicated very accurately in the same and in other patients by different radiologists.

It seems to me that in the none too distant future it will be borne out that we can and should be nearing the goal of speaking the same dosage language in the intracavitary radium treatment of carcinoma of the cervix.

This is not equally true of transvaginal roentgen therapy. The different techniques differ widely. Some therapists employ five fields; others have mapped out four fields; some employ only three. A few employ two transvaginal roentgen-ray fields, and still others only one.

In addition, there is considerable variation as to the timing and method of application of the various intensities. I should logically add that there may be individual indications for all five methods of direct roentgen application to different cervical lesions.

I would like to discuss another point emphasized by Dr. Regato, as follows: "By eliminating the use of radium we avoid the overdosage at the midline; and since there is no fear of adding 'insult to injury' we can use the external irradiation to greater advantage, raising the dose at the lateral aspects of the pelvis."

The injudicious use of either the application of radium or roentgen radiation may produce serious damage to normal structures of the pelvis or intestines. Certainly the use of radium does not handicap the employment of effective external roentgen therapy; in fact, it is desirable to avoid the primary lesion and rectum as well, by means of a 4 or 5 cm. mid-abdominal lead strip, thus concentrating the radium radiation in the parametrium and lateral fields toward the distant glands of the pelvis. Adequately applied, both roentgen and radium therapy methods should sterilize the primary focus.

However, in the five year survival rate of the cases treated by means of external roentgen therapy plus transvaginal roentgen therapy at the Ellis Fischel, Missouri, State Cancer Hospital, between 1943 and 1946, the Stage I and II cases have apparently reacted less favorably than the more advanced Stage III and IV cases. Stage I five year cure rate was 56 per cent; Stage II, 35 per cent; Stage III, 31 per cent; Stage IV, 14 per cent.

It occurred to me that, in part at least, the better results in the more advanced stages could have been influenced by accurately and effectively applied external roentgen therapy, which important part of the therapy program is being given minor consideration in many cancer clinics.

DR. REGATO (closing). Our attempt to treat patients with carcinoma of the cervix by means of roentgen therapy may be best described as an effort to increase the minimum dose of radiation at any point in the tumor while decreasing the maximum at any point in the irradiated tissues. This attempt requires careful study of the interrelationship of the external and internal treatment. We do not claim to have improved the over-all results in the treatment of carcinoma of the cervix, but we have been encouraged by the unquestionably better results in the advanced cases.

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INVESTIGATION OF THE EFFECTIVE ABSORPTION OF RADIUM AND COBALT 60 GAMMA RADIATION IN WATER AND ITS CLINICAL SIGNIFICANCE

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IN RECENT years, the relation of dosage in air compared with dosage in tissue for gamma rays of radium was considered settled and it was assumed that systems for interstitial and intracavitary gamma-ray therapy, which had been calculated in air, were valid in tissues.[16,22,24,33,39] This acceptance is so complete that, in substituting cobalt for radium, for instance, it was taken for granted that conversion factors "in air" are adequate.[20] However, in the last year two studies have been published on the subject, with results differing between themselves and with previous work (Fig. 1).

The early theoretical and experimental work during 1920–1930 on dosimetry around radium sources concerned itself with isodose surfaces measured and calculated in air and in a scattering medium. Due to the lack of proper ionization chambers, and of a theoretical understanding of the problem of scatter, conflicting results were obtained.[1,2,3,6,7,8,11,18,19,26,31]

Sievert's design of a chamber of suitable geometry and size, promising nondirectional properties and better accuracy, encouraged experimentation.[30] Both Griffith[9] and Roberts and Honeyburne,[29] using Sievert chambers, found that within the usual distance of interstitial and intracavitary gamma-ray therapy, the water/air-dose rate

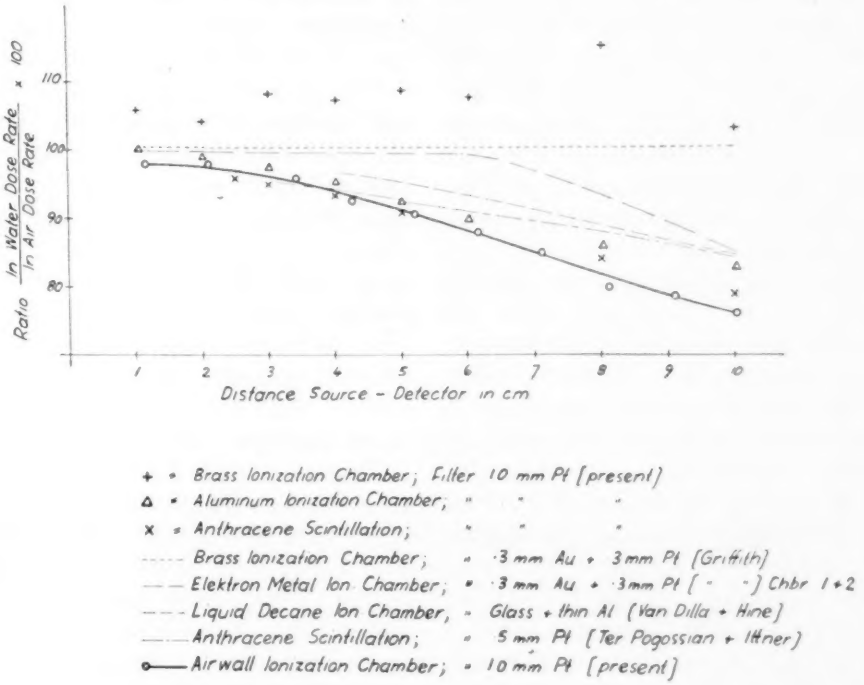
Ratio In Water Dose Rate / In Air Dose Rate x 100
110
100
90
80
1
2
3
4
5
6
7
8
9
10
Distance Source - Detector in cm
+ = Brass Ionization Chamber; Filter 10 mm Pt (present)
Δ = Aluminum Ionization Chamber; " " "
x = Anthracene Scintillation; " " "
Brass Ionization Chamber; " ·3 mm Au + 3mm Pt (Griffith)
Elektron Metal Ion Chamber; " ·3 mm Au + 3mm Pt (" ") Chbr 1+2
Liquid Decane Ion Chamber, " Glass + thin Al (Van Dilla + Hine)
Anthracene Scintillation; " 5 mm Pt (Ter Pogossian + Ittner)
Airwall Ionization Chamber; " 10 mm Pt (present)

FIG. 1. Ratio $\frac{\text{in water dose rate}}{\text{in air dose rate}} \times 100$ versus distance from radium source.

was close to 1 and that systems of dosimetry could be calculated in air and were applicable in tissue. The Paterson-Parker and Quimby systems were so based on "in air" calculations, and the problem thought to be settled.[22,24,25,27] However, in 1944, Quimby mentioned that a correction factor of 3 per cent per centimeter from the radium sources might perhaps be applied.

The problem came back to the fore with the use of scintillation crystals instead of ionization chambers. Potassium iodide and calcium tungstate crystals were obviously giving different dosage rates in water and air, raising the question whether it was due to a lack of "air-like" response, or to the actual difference in dosage rate. Ter-Pogossian *et al.*,[34] on an assumption of air-like response of anthracene crystals,[14] measured dosage rate in air and water in identical geometrical conditions, and obtained results different from those of Griffith. Whereas Griffith had obtained a value of unity for the water/air ratio to a distance of 8 cm. from the source, Ter-Pogossian obtained values less than unity from 1 cm. outwards.

Van Dilla and Hine,[36] using a rather large chamber filled with decane, repeated the experiment, starting at 4 cm. from the radium sources. They did this also for cobalt 60 and found that the water/air ratio was not 1, but that the ratios for cobalt 60 and radium were similar.

Our reasons for repeating these experiments are:

(1) The air-like response of anthracene crystal in air versus water ought to be experimentally demonstrated by taking readings in identical conditions with crystals and ionization chambers.

(2) The air-water equivalence for cobalt 60 and radium ought to be determined from 0 to 4 cm., the region of greatest interest in therapy.

(3) Hine's data were obtained with a liquid ionization chamber. It is desirable that this rather subtle and controversial question should be investigated with classical air ionization measurements.

(4) The results of Hine and Ter-Pogossian differ from one another, and from those of Griffith, showing that some error is attached to one or more of the techniques.

(5) Explanations should be found for the variety of previous results.

The detector used in the first series of experiments consisted of an airwall chamber (being the ionization chamber of a Turner probe[35]), which could be provided with push-fit caps to vary the wall thickness connected via a coaxial cable and extended conductor to a commercial micromicroammeter. The screen of the coaxial cable acted as a guard ring around the cable and eliminated any question of leakage through the insulation due to the effects of radiation. The choice of airwall material for the chamber was dictated by well known considerations.[1,6,10,11] The push-fit caps were of lucite which, while not exactly airwall (effective atomic number 6.46),[38] would introduce negligible error as most of the electrons contributing to the ionization current arise in the inner 1 mm. The effect of the density of lucite on the "in water" readings is about 0.1 per cent. We have ignored this in the present results.

The next step to be made after selection of chamber material was the choice of wall thickness. Two sources were to be used, one cobalt 60 (mounted in tubes of stainless steel, wall thickness 0.3 mm.), the other radium (mounted in platinum sheaths 1 mm. wall thickness). Sheaths of both sources were thick enough to eliminate beta radiation from the sources, but the emitted radiation still contained some secondary beta radiation emitted in a forward direction due to interaction of the gamma rays with the sheath material. The difference in spectra made it desirable to investigate the effects of difference in wall thickness of the detecting chamber with both radiations. The gamma-ray source in each experiment was rigidly mounted 4 cm. away from the center of the ionization chamber in an apparatus to be described later, and changes were made in the wall thickness by adding lucite caps to the

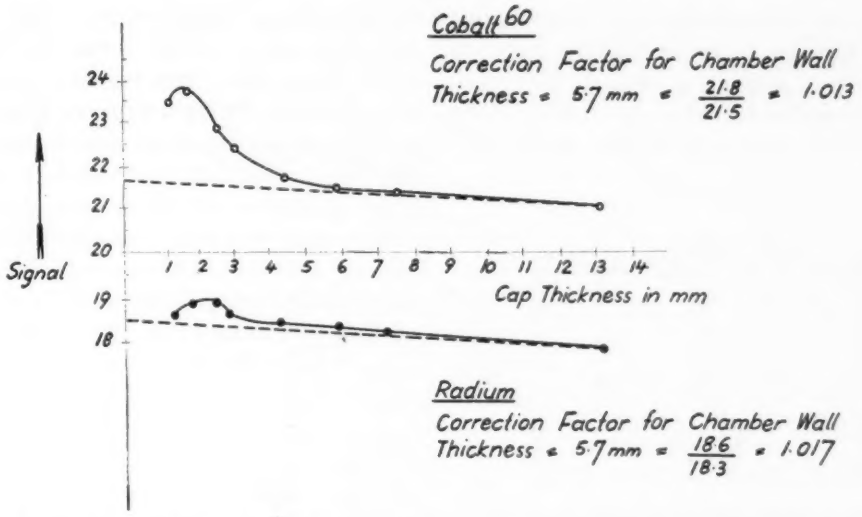

Fig. 2. Graphs showing variation in ionization chamber current with cap thickness.

original chamber.

The results of these experiments were graphed on semilog paper (Fig. 2). The graph may be considered to be the sum of three effects:

(1) The increase of current due to increase of wall thickness reaching a saturation value at the maximum range of secondary electrons in the wall material.

(2) The decrease in current as the secondary electrons from the source sheath are removed from the measured beam by absorption in the wall of the chamber.

(3) The decrease in current due to absorption of gamma radiation in the wall material.

Effect (1) contributes to a rapid rise to a peak value followed by a rapid fall as effect (2) becomes predominant; this rapid fall becomes a gradual decline as the absorption of beta secondaries is complete and (2) reaches saturation value and effect (3) becomes the predominant variable.

In arriving at the true electron flux across the cavity represented by the ionization chamber, it is desirable: (a) to have sufficient wall thickness to attain "electron equilibrium," *i.e.*, to have such a thickness as to insure that all electrons generated at the surface of the sensitive volume will be absorbed in the wall material; (b) to eliminate all the secondary electrons from the sheath of the source; (c) to be able to correct for gamma-ray absorption in the material of the wall of the chamber.

It can be seen from inspection of the graphs (Fig. 2) that a wall thickness of the order of 5.7 mm. fulfills all these requirements. The peak signal due to the presence of secondary electrons from the source has been passed and the gradual decline due to effect (3) above is a straight line on the semilog graph and may be extrapolated to the zero wall thickness with reasonable accuracy. This wall thickness is a reasonable choice for both radiations despite the difference in spectral distribution; this is in accordance with the theory of the range of secondary electrons in water given in such data as those of Cormack and Johns.[4] These wall thickness considerations are of importance only in the "in air" readings; no correction is necessary for the "in water" measurements.

A total wall thickness of 5.7 mm. was therefore used in all experiments. It was made up of the air equivalent chamber, a plastic cap, and a covering of thin rubber (0.2 mm. thick) to provide a waterproof sheath.

The ionization chamber was cylindrical with a hemispherical end of internal diameter of 3 mm. From consideration of

the geometry and mechanism of ionization production,[32] the error in measurement of intensity from a point source at the minimum distance used (the worst conditions possible) of 1 cm. was of the order of 1 per cent.

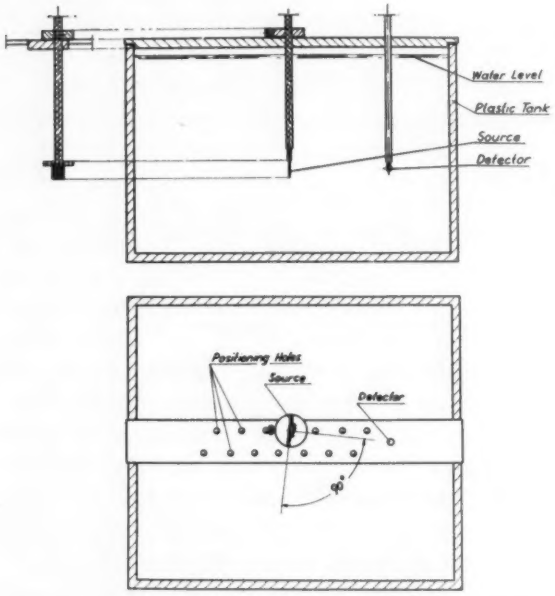

FIG. 3. *The Apparatus.* Spanning the tank (30 cm.^{3}) is an aluminum plate of 1.3 cm. thickness in which a tight fitting has been drilled to take the chamber and the stem on which it is mounted. The stem is inserted so that the mid-point of the ionization chamber coincides with the mid-plane of the tank and the minimum distance from the chamber to a wall is 5 cm. Holes are also drilled through the plate at 0.5 cm. intervals of distance from the center of the ionization chamber. These holes were arranged in two vertical rows to 0.5 cm. intervals in one and the unit centimeter holes in the other, thus allowing 1 cm. between centers and the use of a larger diameter mounting for the gamma-ray source which is inserted through these holes. This rod mounting is fitted with an adjustable collar which provides additional lateral stability and a means of adjusting the depth of the gamma-ray source relative to the ionization chamber.

The ionization chamber was tested for directional properties. It was found to possess none to within 5 per cent, even when radiation came from the sources screened by the stem, the stem being of "light" material (plastic, and thin aluminum wire and tube). This chamber was now used in an apparatus (illustrated in Fig. 3) which consisted of a plastic tank of dimensions such that a water phantom of 30 cm.^{3} could be provided. Mounted on the phantom was a means of locating the source and detector relative to one another and to the tank. The geometry of the source-detector arrangement was not disturbed between the in air and the in water readings, so that reproducibility of distance was of secondary consideration. It was, however, repeatable with an accuracy of the order of 0.25 mm.

The tank was then surrounded at a distance of 10 cm. by lead bricks to protect the operators; the use of 120 mg. equivalent radium and equivalent amounts of cobalt 60 made this desirable. Runs were made, however, in the center of a large room and no detectable differences between the readings obtained in this situation and those resulting from working behind the lead castle were observed. Similarly, no change could be attributed to the presence of the empty tank surrounding the gamma-ray source and detector when making "in air" measurements. Experiments were conducted to ascertain the effects of position of the radium and detector relative to the sides of the tank. If either component of the system was farther than 2 cm. from the tank wall than for a constant separation, movement inside the phantom produced no variation in current. The geometry used in the experiment was therefore not in the critical region. When the source-detector distance was large, it was necessary to use a number of radium or cobalt tubes. To keep the same effective filtration, the tubes were mounted in a plane perpendicular to the source-detector line. The area of this plane was 1 by 0.5 cm. for the cobalt, and 1.5 by 2.5 cm. maximum for the radium. When the distance was small, a single source was employed; this, of course, had length. Corrections were made so that the mean distance from source to detector could be plotted (Fig. 1 and 4).

The experimental procedure was as follows:

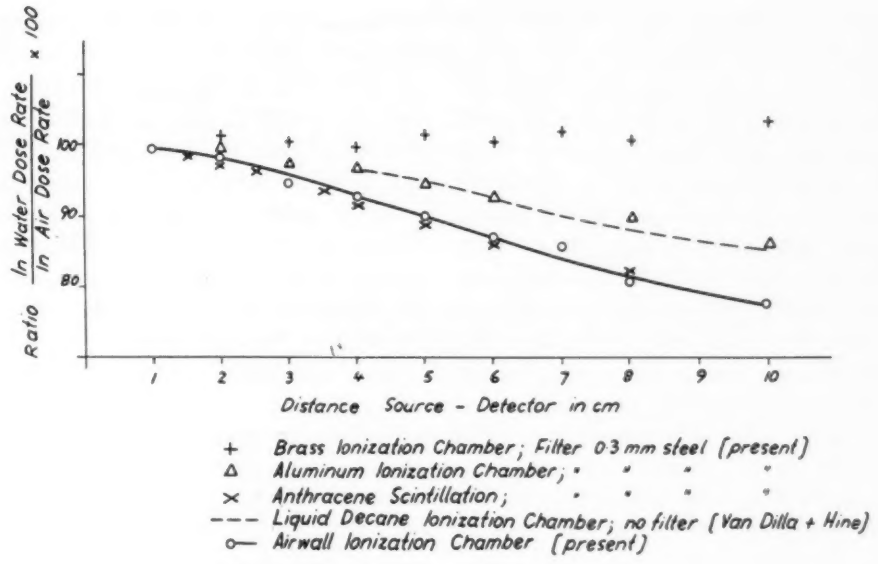

FIG. 4. Ratio $\frac{\text{in water dose rate}}{\text{in air dose rate}} \times 100$ versus distance from cobalt source.

(1) The zero reading of the micro-micro-ammeter was read.

(2) The gamma-ray source (which had been inside a lead castle during operation) was inserted through the appropriate distance hole in the perforated plate, until it came to rest with the adjustable collar on the plate. (This had previously been adjusted so that the active center of the source was horizontally in line with the active center of the detector.) The micro-microammeter reading was taken as soon as the movement reached a steady reading.

(3) Water was introduced into the tank and the level brought up to 30 cm. The total "in water" current was now read from the micro-microammeter.

(4) The gamma-ray source was immediately returned to its "castle" and the zero reading of the micro-microammeter taken.

The "in air" current was obtained from readings 1 and 2 and corrected to zero wall thickness, by data from the cap experiments. The "in water" current was obtained from readings 3 and 4, no wall correction being necessary here as the medium and the chamber wall were of the same density and effective atomic number, and therefore their presence made no difference to the gamma-ray flux.

Graphs of the ratio $\frac{\text{in water current}}{\text{in air current}}$ at distances up to 10 cm. were plotted (Fig. 1 and 4). Using these data, calculations or measurements "in air" can be corrected to be used in interstitial or intracavitary gamma-ray therapy, either for radium or cobalt 60 sources, sufficiently filtered to absorb the primary beta radiation. Actually in interstitial work, the correction is of no practical significance, as it can be seen that for distances less than 3 cm. the factor is small compared with the errors likely to arise due to other reasons. In intracavitary therapy, *e.g.*, in treatment of carcinoma of the cervix, calculations at distances of the order of 5 cm. which ignore the correction for absorption will contain errors comparable in magnitude with those usually accepted as upper limit for clinical purposes (10 per cent), and a correction factor may become worth while.[22]

The effect of use of materials other than "air wall" for the chamber were investigated by making caps of brass and of a compounded arrangement of elektron metal

and aluminum. The combination form was used as the effective atomic number of the two metals is the same, and elektron metal is more easily inserted in fine threads, etc. The experiments were repeated with these two types of chambers, using the same apparatus and procedure. The wall thickness in the brass chamber was 1 mm., and 3 mm. in the aluminum-elektron metal combination. They were therefore thick enough to remove the secondary electrons from the source. No attempt was made to correct the "in air" readings for wall absorption. This would not have affected the general form of the results very much. It can be seen that the brass chamber yields misleading results, comparable with those reported by Griffith,[9] using the same type of chamber. The difference between the results for cobalt 60 and radium show that the effective wavelength of the radiation from cobalt 60 in a scattering medium is different from that of radium several centimeters away from the source. Aluminum yields results which differ from those of Griffith using similar material, but much nearer to those obtained with an airwall chamber which is in agreement with the deduction submitted by Gray[10] for a material of low atomic number. The use of aluminum chambers for measurement of interstitial implants would, therefore, appear to be justified.[5,15,21,30] Measurements made at distances of the order of 10 cm. or greater in a scattering medium would, however, appear to be in need of a small correction. It should be noted that the chamber used by Griffith had an internal diameter of 8 mm. and such chambers would not yield results with 5 per cent accuracy at distances smaller than 3 cm.[32] There appears to be insufficient difference between the

$$\text{ratio } \frac{\text{dose in water}}{\text{dose in air}} \text{ as measured for radium}$$

and cobalt under the conditions of this experiment, to account for differences in biological effects reported for equal doses, calculated on an "in air" basis.

The experiment was repeated using an anthracene crystal detector and equipment similar to that employed by Ter-Pogossian *et al.*[34] The anthracene crystal, approximately 2 mm.^{3} was cemented with transparent plastic cement (Duco) to the end of a polished lucite rod (light conductor), previously selected for low scintillation activity, of 3 mm. diameter. The scintillations in the anthracene were detected by a photomultiplier tube, type 1P28, connected to a stabilized voltage supply of 1,100 volts. The magnitude of the current was measured by the current generated in the last stage by means of a galvanometer with sensitivity 0.0025 microampere/mm. This instrument was selected for its robustness and sensitivity. The system proved very stable and tests showed the current attributable to the gamma-ray flux to be proportional to that flux. The photomultiplier was mounted in its housing outside the lead castle, and the light conducting rod, surrounded by an aluminum sheath terminating in a plastic cap in the vicinity of the crystal, was inserted through a push-fit hole in the side of the castle and through a water-tight port in the side of the plastic tank. The cap thickness was determined by the same method as employed for the ionization chamber and a same cap thickness and correction factor obtained. Small corrections obtained by shielding the crystal were applied for scintillations in the light pipe. The crystal center coincided with the mid-plane of the tank. The gamma-ray sources were mounted on a carriage carried by a tracking mechanism so that the distances could be accurately reproduced to within 0.1 mm., the height of the gamma-ray sources relative to the crystal adjusted and the absolute value of the distance between crystal center and gamma-ray source varied at will. A similar experimental procedure as before was followed, except that the gamma-ray source was not removed between distance readings, the stability of the zero being such that it was not considered necessary to check it between distance readings. The experimental points and a comparison with

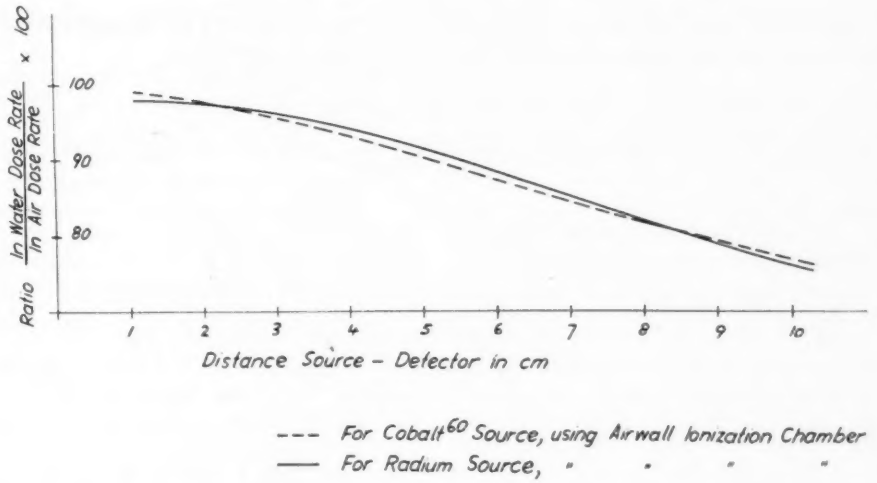

FIG. 5. Ratio $\frac{\text{in water dose rate}}{\text{in air dose rate}} \times 100$ versus distance from cobalt and radium sources.

the airwall chamber results can be seen in Figures 1 and 4.

In conclusion it may be stated:

(1) The assumption of equivalence of water and air measurements is reasonable for distances up to 5 cm. for most clinical purposes, but corrections should be taken into consideration in comparing finer points of technique, and so forth.

(2) The value of

$$\frac{\text{gamma-ray intensity in water}}{\text{gamma-ray intensity in air}}$$

ratio obtained by experiment depends greatly upon the apparatus employed and unless carefully selected as to effective atomic number, wall thickness, and so forth, is likely to be misleading. The influence of effective atomic numbers is as important for crystal detectors as ionization chambers.

(3) Anthracene is sufficiently airlike to be used as a measuring crystal for cobalt and radium gamma rays in a scattering medium, when utilized as described above. It should be surrounded by a cap of adequate thickness for measurements in air.

(4) The use of aluminum ionization chambers for dosage control is tolerable for distances up to 5 cm. from the radium.

(5) Any variation of biological effects between cobalt 60 and radium gamma-ray sources calculated to give equal doses in roentgens on an "in air" basis is not due to a difference in the gamma-ray dose delivered in a scattering medium (Fig. 5).

(6) The graphs of the $\frac{\text{water}}{\text{air}}$ ratio for a chamber of high atomic number show that the effective wavelength of the total radiation in a scattering medium due to radium is longer than that of cobalt 60.

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STATE CONTROL OF PROTECTION AGAINST IONIZING RADIATION*

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THIS report points up some problems in the development of a philosophy and codes of practice relative to the use of radiation and its control by the state. Reference is made to practices in various countries, but it should be made abundantly clear that no criticism of these practices is intended or implied. The terms of reference are set by conditions as seen by the author in the United States, are his own views, and do not necessarily reflect any official acceptance.

ENGLAND

England was probably the first country to set up any sort of code of practice or recommendations relating to protection from roentgen rays and gamma rays of radium. Its general approach to the problem has been fairly close to that in the United States. At the present time England has a radioactive-substances act, similar to the United States Atomic Energy Act,[17] and included in this are some paragraphs relating to protection against radiations from radioactive isotopes. This act is primarily an enabling measure and among other things gives the ministers authority to prepare such regulations as they see fit to control radiation hazards. As in the United States, a certain degree of enforcement of good radiation safety practices is brought about through the control of the supply of radioactive material; in England by the Atomic Energy Research Establishment.

Although at the present time British medicine is under the operation of the government, there are no laws relating specifically to roentgen-ray protection. Good protection codes closely related to the recommendations of the International Commission on Radiological Protection are available, but compliance with them is on a voluntary basis. These were originally prepared by the British X-ray and Radium Committee made up of representatives of the British Institute of Radiology, the Institute of Physics, the Royal Society of Medicine, the Faculty of Radiologists, and the National Physical Laboratory[1] under a procedure closely resembling that of the National Committee on Radiation Protection in the United States. Codes in the future will be developed by an advisory committee under the radioactive-substances act. Radiation protection surveys and services are available at cost through the National Physical Laboratory, an organization corresponding to the National Bureau of Standards in the United States. There is no system of licensing other than that covered by the radioactive-substances act, which applies primarily to the use of radioactive isotopes.

England is now in the process of establishing a directorate of radiation protection under the cognizance of the Medical Research Council[2] and Ministry of Health. This organization will correlate all protection activities, the development of codes of practice, and the establishment of permissible dosage levels. At the moment, no legal action with respect to radiation protection is contemplated; the problem of enforcement will, in general, remain on the present basis. Limited statutory regulations may be developed, but these will only require compliance with maximum permissible dosage levels established by appropriate bodies. Responsibility for the development of technical information relating to radiation protection willl remain largely in the hands of the National Phys-

* Full text of paper presented at Seventh International Congress of Radiology, Copenhagen, Denmark, July 19–25, 1953.

ical Laboratory, where it has been for the past thirty years or more.

SWEDEN

Sweden is another country that has for years taken a lead in the development of radiation protection philosophy and codes. This country also has a state health insurance plan wherein the government has a considerable degree of control over the use of any sources of radiation.[3]

Under this plan, protection against radiation from all sources is called for; and as a condition to the holding of a license to perform work with radiation or to possess radiation sources, the state has the right to make inspections of any radiation sources that it chooses.

The safety recommendations of Sweden are developed and the inspections and safety procedures are carried out by the Radiophysics Institute of Stockholm, which plays the major role in radiation control and in essence passes on the licensing of all radiation uses.

Sweden's basic act is in the main an expression of philosophy, and carefully avoids the inclusion of technical data or information that may be altered with advance of the science. It appears that their control is operated on a flexible practical basis, rather than a formal legal basis alone. It is the Swedish philosophy that "a formal prohibition for persons in radiologic work to be exposed to doses above a certain stated limit would imply practical and legal consequences which might involve great inconveniences. Instead of stipulations on a maximum allowed dose, their proposals give some rules which, although lacking the character of strict regulations, should nevertheless be observed in the work. The regulations mainly contain only the fundamental demands of radiation protection. Comments needed, and advice and instructions, have been separated from the regulations proper. Thus, future experience in the radiation protection field can more efficiently be put to use in this 'advice and instructions' part which can be amended and completed with less formalities than established regulations."[4] This expression of Swedish philosophy is very similar to that which has long prevailed in England and the United States.

NEW ZEALAND

The Dominion of New Zealand has probably gone further than any other country in developing a tight and rigid system for the licensing, regulation, and inspection of roentgen-ray equipment and of sources of radiation from radioactive materials. The development of the New Zealand philosophy relating to roentgen-ray protection presently represents one extreme in government control.

The primary authority lies in the 1949 act for ". . . the Control of Radioactive Substances and Irradiating Apparatus . . . ," which includes the licensing of all radiation usage within the country.[5]

Radiation protection regulations were established in an Act of July, 1951, and their promulgation is based on recommendations by a Director General. A set of regulations has been developed that includes strict licensing for the use of all roentgen-ray and other radiation equipment.[6] The granting of licenses is in the hands of the Minister of Health.

In the 1951 Act have been set down in law certain detailed rules but, in addition, some degree of supplementation of the recommendations of the Director General is allowed.[7] These recommendations are not binding, nor are they a part of the regulations.

New Zealand has four classes of licenses: "(a) Licenses for all purposes; (b) Licenses for diagnostic or therapeutic purposes; (c) Licenses for dental diagnostic purposes; and (d) Licenses for industrial, experimental, testing, demonstration, veterinary, research, or other purposes." The act then states that "Licenses for all purposes may be granted only to radiologists or radiotherapists" and presumably this includes those purposes listed in class (d). There does not appear to be any experience or training re-

quirements for class (d) licenses alone. Limited licenses for classes (b) and (c) may be granted only to persons who, in the opinion of the Minister, have special knowledge in the use or application of radioactive substances or roentgen rays for the purposes covered by the license.

The work week in New Zealand is taken as thirty-five hours averaged over any four week period. In addition to normal holidays, radiation workers are required to be given at least four weeks of annual holiday, of which at least two weeks must be taken consecutively.* In a following paragraph, it is stated that radiologists may work "for such hours as he considers necessary" without regard to any stipulations for other workers.

The time element in exposure is not specifically treated. For example, it is required that all rooms in which the radiation level exceeds 5 mr/hr. be labeled as dangerous. There appears to be no provision for exposure at higher levels; but with considerable intervals between exposures, the average might be considerably less than the permissible weekly level. It is true that the mere labeling of the room as dangerous does not mean that the permissible exposure of the occupants will be exceeded but the implication is there nevertheless.

As a matter of fact, the general trend for the past fifteen years has been to integrate the exposure over longer and longer time periods, since it is considered to be quite unrealistic to integrate exposure over times as short as a minute or hour, or even a day.

GERMANY

Germany has had, for a great many years, a set of roentgen ray protection codes under the "DIN Rönt" series.[9] According to latest information, these codes are being revised and brought up to date. At the present time, Germany apparently has no immediate plans for legalizing the codes through legislative action. It is apparently intended, as in the United States, to have them available for voluntary use, and to rely upon the courts to make any necessary decisions based on what is considered to be good practice.

The preparation of the codes and the provision of means for survey and protection device rest, for the most part, in the hands of the Physikalisch-Technische Bundesanstalt, the German organization corresponding to the National Physical Laboratory in England, or the National Bureau of Standards in the United States.

FRANCE

In France, roentgen-ray and radioactivity protection standards have been prepared by l'Union technique de l'Électricité and mainly apply to the equipment itself.[10,11] Promulgation of these rules appears to be through the Ministry of Public Health and Population by means of an interministry order by such ministries as defense, commerce, labor, social security, etc. [12]

The order calls for inspection and approval but, as nearly as can be determined, there is no force of law behind this approval requirement. In other words, it appears that the situation there is very similar to that in England and the United States, where enforcement is through compliance and cooperation. It is interesting that the French codes exclude research laboratories and manufacturers' developments.

The interministry order refers to the use of protection rules but relies upon those developed by l'Union technique de l'Électricité.

CANADA

At the present time, Canada has no national radiation safety code, but one is being developed. Strict radiation control is exercised only for the use of isotopes and, as in the United States and England, this is done primarily through the Canadian Atomic Energy Control Act.[13] It is the

* This particular philosophy had been in the International Recommendations for some years but was generally agreed in 1950 to be without physiological foundation and was hence taken out of the International Recommendations. The only remaining proponent at the International meetings in 1950, while agreeing that it had no physiological importance, nevertheless would have liked its retention since it gave a good talking point in hiring technicians.

stated intention of those who are working on radiation protection codes to move slowly and to profit by the experience and mistakes of other countries. One group is drafting regulations, which are as yet not available to the public, and is giving some consideration to licensing provisions, penalties, monitoring services, etc.

At the present time, Canadian protection practice is based on the rules of the International Commission on Radiological Protection together with "such additional safety methods and procedures as may be prescribed by the Minister."

It appears that the matter of enforcement, if any, of national safety regulations would be left up to the provinces, which have already expressed themselves as feeling that existing provincial regulations are sufficient for the control of radiation within their area of influence. At present, the detailed means and methods of protection are up to the individual.

UNITED STATES, CALIFORNIA

So much for procedures and practices in other countries. In the United States, the nearest approach to a legal document on radiation protection is probably an industrial safety order of the State of California.[14] This is a relatively brief order prepared by the Division of Industrial Safety and deals mainly with the permissible dose, without going into a great deal of detail regarding ways and means for achieving protection. The California order, now about three years old, encountered some of the difficulties pointed out in connection with national acts. These have been recognized and are now in the process of being corrected. However, to point up the problem, some of the original difficulties are discussed here even though they are now being rectified. For example, the original California order expressed permissible dose in roentgens per day. As already pointed out, this is definitely too short a period over which to integrate personnel exposure. Also the permissible concentrations of radioactive material in air were in disagreement with those recommended by the National Committee on Radiation Protection and the International Commission on Radiological Protection. In this case, it is not too difficult to rectify such details since it necessitates only the issuance of a change-order or a revision of the original, after required public hearings on the subject.

No reference was given in the California order to acceptable codes of practice or to details regarding safe procedures, nor was it indicated where such information could be obtained. Widely accepted codes of practice are available through the National Committee on Radiation Protection and these could have been essentially adopted by reference. This is a common and useful practice, and is exemplified by the widespread use of the National Electrical Safety Codes, which in themselves have no legal status. The new order will refer to the recommendations of the National Committee on Radiation Protection.

The original order states that because of the likelihood that permissible dosage levels will be changed, periodic hearings will be held to decide what figures shall be used in the order. Much time and effort would have been saved if it were merely stated in the order that the permissible levels of radiation exposure would be those set forth by, for example, the International Commission on Radiological Protection or the National Committee on Radiation Protection. One might visualize the bizarre situation of each of the forty-eight states periodically revising their permissible dose levels.

Another interesting point occurred in the section on the maintenance of protective devices. After what is called for in this category was spelled out, it was then stated that "medical or dental equipment which produces ionizing radiation may be operated in an emergency even though it is known to be defective. In such cases, reasonable precaution shall be taken to protect employees who are known to be exposed to such radiation." It would appear that the inclusion of this one exception

would have put into court practically every single apparent violation that might have come to the attention of the authorities. This section will be omitted from the new order.

UNITED STATES, MASSACHUSETTS

In 1951, a bill was introduced into the Massachusetts State Legislature to establish "An Act Extending the Authority of the Department of Public Health to Regulate Methods of Handling and Disposing of Radioactive Materials and Use of Apparatus Emitting Ionizing Radiation."[15] This was pressed as an emergency law and would have given to the State Department of Public Health the responsibility to "prescribe and establish rules and regulations to control the transportation, storage, packaging, sale, distribution, use, production and disposal of radioactive materials, and the installation and operation of equipment and processes which emit ionizing radiation which may affect the public health or the health of persons exposed to radioactivity or ionizing radiation." It was stated that, "Said rules and regulations, after being so prescribed and established, shall have the force of law," and "Any such rule or regulation made by the department order under this section shall take effect upon publication thereof in a newspaper in each county."

The dangers of the proposed bill were recognized by medical authorities in the state and it was not passed. A committee subsequently established to investigate the problem has not yet issued a report. It is mentioned here only to show the potential dangers of hasty consideration of the radiation protection problem. As originally written, it would have given almost limitless authority to a state body in a highly technical field in which that body had, at the time, only very limited experience.

RADIATION PROTECTION LAWS IN GENERAL

Inclusion of technical detail and numerical quantities in legislative acts relative to radiation is deemed impractical by many experts in the field. One basic reason for this is the fact that technical data are very apt to be changing frequently in fields growing as rapidly as those involving radiation. Permissible exposure levels of today are apt to be changed tomorrow in the light of improved knowledge. Each such change would then require a change in the basic act if the original included specific values. This could be both costly and cumbersome and could introduce serious delays in making new information available for use.

Practical difficulties arise in the development of a legal act covering a complicated technical or scientific field. Laws are usually generated by lawyers who in turn call in special consultants when the area is highly technical. But in the endeavor to develop a legally tight document, it may appear necessary to define in great legal detail factors that, in fact, cannot be rigorously defined. It is often better to leave some matters to common practice and settle the rather rare argument in court rather than burden the great majority of the situations with unwieldy restrictions and limitations.

It sometimes would appear the law has stepped in where science has long feared to tread. For example, one set of regulations defines and uses the term " 'proximity' in relation to irradiating apparatus or radioactive substance," as the "position in which a person may be liable to an exposure in excess of one tenth the maximum permissible exposure." Left out is any mention of the duration of the exposure, and without this the definition has no practical value. Yet any inclusion of the time factor would render the definition too complicated to use. From a legal point of view the definition makes the law enforceable even though technically the situation is wholly unrealistic and untenable.

Another attempted definition is that of "radiation work," and hence by implication, a radiation worker. The National Committee on Radiation Protection in the United States has struggled for many years with the problem of trying to define radiation work or a radiation worker. It was

finally decided that a suitable definition would fill a small book, and after a great deal of consideration, it was agreed that from either a useful or legal point of view, it is essentially impossible.

If one has laws, perhaps situations or factors such as those mentioned above must be defined; and in spite of the weaknesses pointed out, it may be that the definitions are as good as can be attained. The basic difficulty is the development of an approach to the protection problem that necessitates such definitions in the first place.

Some acts or regulations contain certain specific requirements regarding blood examinations. While these were technically reasonable when the regulations were established, they are now obsolescent in view of the Stockholm agreements of 1952. No great harm is done aside from requiring unnecessary blood examinations; but in these cases where the statements are now in law, additional legislation is required to rectify or remove them.

The magnitude of any enforcement problem varies materially with the size and geography of the state concerned. For example, New Zealand is not a large country either numerically or geographically, nor does it have, at the present time, a large number of radiation installations. According to 1952 figures[8] it has a total of 688 X-ray plants, of which 275 are for diagnosis, 29 are for therapy, 260 for dental work, 62 for shoe fitting, and the remaining 52 for miscellaneous uses. The 40 uses of radioactive substances listed include 24 for therapy. Enforcement of the New Zealand regulations may not be an insurmountable task. The situation is vastly different, however, from that in larger and more highly industrialized countries such as the United States, England, or Germany, where it probably would not prove practical without the development of an enormous enforcement staff out of all proportion to the seriousness of the problem.

The question of states, provinces, counties, and even cities adopting radiation protection codes has come up numerous times in the past twenty-five years. Inherently, there may be no serious objection to this, *per se*. The difficulty, of course, is that once a code is adopted its enforcement requires a law or ordinance and the next step may be licensing. Lawmakers, however, are too prone to compare the radiation industry with, for example, the plumbing industry. Licensing of a radiation installation is essentially a licensing of its operators and this invades a field far too complicated to be adequately managed by the average legislative bodies or even special technical groups available in many states.

Unreasonable or non-understanding interpretation of radiation safety practices could, if enforced rigidly, completely stifle a research or medical installation, the very existence of which implies its management by competent and trained individuals. It is, of course, recognized that some radiation machines may come into the hands of unqualified persons and that such persons require help and guidance. It is believed that they can best be helped, not by law, license, and regulation, but by education and guidance such as that provided by the International Commission on Radiological Protection, the National Committee on Radiation Protection in the United States, and similar advisory groups; the former approach may catch a few offenders, but do untold harm to the much larger group that knows what it is doing. Indiscriminate techniques are not called for. Radiologists are in a sense controlled through their training and experience. Good protection practice in industry is exercised through the influence of labor unions. Both are controlled through the threat of suit at law. Both are constantly striving to improve their protection and both welcome help and guidance wherever they can get it. Restrictive laws can benefit them little.

There need not be too great concern over the users of radioactive isotopes; in most countries the circulation of isotopes is limited and their use is closely controlled through atomic energy acts. On the other hand, there are some roentgen-ray machines that fall into the hands of persons

who lack full medical and radiological training; shoe-fitting roentgen-ray machines are a good example. It might be reasonable to require licensing for such installations but there is then the problem of defining the borderlines between these and the more obviously legitimate uses. The non-radiologist medical doctor is a large user ordinarily having little or no radiation training. He would gladly be educated and controlled through his medical organization. In any case, his work-factor is usually so low that he dose not often develop a serious radiation hazard.

In the development of any law on radiation protection, one of the most objectionable features appears to be the requirement of licensure. The usual justification for this is that it provides the best means for determining where radiation sources exist. On the other hand, as already pointed out, this may easily vest a few people with an undesirable degree of control. It seems a pity that in order to eliminate a few relatively small sources of radiation hazard the risk must be run of endangering all of the important and, on the whole, well controlled radiation industry.

The desired result can be achieved just as easily by requiring the registration of radiation sources either by individual or by institution with a penalty for failure to register. Surveys or inspections could be subsequently effected at the discretion of the control agency. They in turn would provide whatever guidance or advice may be indicated. Not a single compulsory law would be required, for few, if any, users of radiation would dare operate with facilities that have been demonstrated as unsafe.

A small fraction of the cost of enforcing laws on radiation protection could, if spent on prophylaxis instead, accomplish far more than all the conceivable laws and regulations.

PROTECTION CODES IN THE UNITED STATES

At present, there are no States laws on radiation protection in the United States although at least two States are considering developing laws or enabling acts. The problem is much more complicated than in most countries by virtue of the fact that there are forty-eight States, each jealous of its own laws without regard to those of any other State. It might seem that a national law could easily solve this problem, but this is not so. National laws usually apply to situations where more than one State is involved; but this is rarely the case in radiation protection except for the shipment of radioactive materials, which is regulated by the Interstate Commerce Commission. Furthermore, because of the geographical size of the country, enforcement of radiation laws at the national level would be extremely cumbersome and costly. By way of emphasizing the magnitude of the problem it may be pointed out that the General Motors Corporation, alone, has nearly twice as many roentgen-ray machines as in the whole of New Zealand.

It should also be mentioned that in the United States, there is a traditional dislike of laws unless they are absolutely necessary.

It is worth noting that if every State in the United States should decide to develop a law or order or some other legislative action relating to radiation protection, there would be an excellent possibility of producing chaos in the whole field of radiation protection, to the point, for example, where a roentgen-ray equipment manufacturer might be faced with the necessity of making his equipment comply with the requirements of several or several dozen different State codes. It is felt that this is a real danger in the development of any legislative action on the part of the States. On the other hand, one can imagine that some of the States may, for reasons believed important, want to set up a means whereby some degree of radiation safety can be assured for workers within their areas. Unless, however, this is done on a carefully planned and unified basis, there will unquestionably be encountered the same sort of difficulties that once existed in inadequate, inflexible, and obsolete building and plumbing codes,

the operation of which did a great deal to increase the costs of homes. If care is not taken, the good intentions will only increase greatly the cost of medical care; this, in turn, affects the pocketbooks and the health of a large number of people in the country.

Recommendations for good protection practice on a voluntary basis are made by the National Committeee on Radiation Protection, a discussion of which is presented in the following paragraphs.

NATIONAL COMMITTEE ON RADIATION PROTECTION

For the past twenty-five years the major effort directed toward radiation control and safety in the United States has been through the efforts of the National Committee on Radiation Protection.[16] This is a voluntary group of authorities representing the major areas of interest in the radiation protection field, and was initially set up in 1929 upon the specific recommendation of the International Commission on Radiological Protection. At that time there were at least three committees on roentgen-ray and radium protection functioning under the three national radiological organizations in the United States. In spite of the fact that the membership of these committees overlapped to some extent, their recommendations differed somewhat in detail and hence there were no nationally recognized safety standards or codes of practice. This situation exposed itself at the meetings of the Second International Congress of Radiology in 1928, and resulted in the recommendation of the International Commission on Radiological Protection that each country have a single national committee.

The committee, as established in 1929, was named the Advisory Committee on X-ray and Radium Protection because from the outset it did not feel that it should have any regulatory responsibility or powers. A brief review of its early activities is presented here, since much of the basic philosophy established over twenty years ago is still adhered to.

The objectives of the Advisory Committee were to bring together persons working actively in the radiation protection field, to formulate the general principles of radiation protection, and to establish codes of practice in specialized areas. The scope of action was directed primarily to medical needs, for two reasons: (1) most of the harmful effects of radiation are biological in nature, and (2) the vast majority of radiation usage was then in the medical field. In any case, it was believed that the basic principles developed for medical needs could be readily applied to industrial and laboratory needs. This may not be completely realistic today, since some of the industrial situations involve basic problems never encountered in strictly medical applications.

In the original make-up of the Advisory Committee, members were designated by the several radiological and medical societies and the roentgen-ray equipment manufacturers. Upon the suggestion of the radiological groups, the National Bureau of Standards was asked to sponsor the activity since it constituted a permanent organization with no special interests, and had a continuing program of research in the radiation protection field. Work was centered in the X-ray Section, now the Radiation Physics Laboratory. The reports of the Advisory Committee were referred back to the participating or other groups for their acceptance and use if they so chose.

In 1946 the problems in radiation protection had become so manifold that the Advisory Committee decided the number of participating organizations should be increased and the total membership considerably enlarged. At the same time the name was changed to the National Committee on Radiation Protection.

Today the Main Committee of the National Committee on Radiation Protection is made up of representatives of many organizations: United States Public Health Service, United States Atomic Energy Com-

mission, National Electrical Manufacturers Association, American Medical Association, Radiological Society of North America, American Roentgen Ray Society, American Radium Society, American College of Radiology, Department of Defense, and National Bureau of Standards. It is quite likely that other organizations will be added as the needs develop. For example, it may be necessary to add a representative of the State Department since the field of international relations may be entered when radioactive wastes are to be dumped at sea. It may be desirable to add representation of the morticians since, as time goes on, they will be called upon to handle more and more cadavers containing radioactive contamination. Preparation for radiation protection as a part of civil defense in the event of atomic warfare also presents important problems, the solution of which may differ considerably from those necessary in normal peace-time operations. These problems will require detailed consideration, once the basic philosophy of radiation protection is clearly established, and representation of the Federal Civil Defense Administration may be desirable.

The relationship of the National Committee on Radiation Protection to the United States Atomic Energy Commission is illustrative of the broad problem of developing a workable protection philosophy. In 1946 when the National Committee was reorganized, this was discussed with the Atomic Energy Commission at great length. The Commission had decided that it would be in an untenable position if, as the largest single user of radioactive materials, it also established its own safety rules. It could have been subjected to criticism on the basis that it was setting radiation levels to suit its operating needs rather than the safety of the worker. Accordingly, the Commission requested the National Committee on Radiation Protection to make studies and prepare basic recommendations and codes of practice that could provide a basis for Atomic Energy Commission operations.

The National Committee on Radiation Protection has been mindful of its responsibility in relation to the Atomic Energy Commission and, on the whole, it is felt that the National Committee on Radiation Protection has met it in most essential details. It has not been a simple and strightforward problem. For the vast number of radiation workers in the country as a whole, it was important not to load the subcommittees with Atomic-Energy-Commisssion-interested members. At the same time, it was clearly recognized that many of the most experienced persons in the field of radiation protection were employees of the Atomic Energy Commission or its large contractors.

In the preparation of a report, all reasonable steps are taken to obtain pertinent reviews by groups outside the committee. Any worthwhile comments and suggestions received after the report has been published are taken care of as separately published notes, addenda, or simply held for the next revision, depending on their urgency.

One of the most important ties of the National Committee on Radiation Protection is with the International Commission on Radiological Protection. As mentioned above, it was the influence of the latter that brought about the consolidation of protection activities in this country in 1929. The influence has, to some meassure, been reversed; for when the International Commission on Radiological Protection was reorganized in 1950 and a series of subcommittees established, they were made to match as closely as feasible the structure of the National Committee on Radiation Protection. In fact, the chairmen of several of the subcommittees of the National Committee on Radiation Protection are also chairmen of the corresponding subcommittees on the International Commission, and at least two reports of the National Committee on Radiation Protection will be used as a pattern for international recommendations in 1953.

In 1948 the Subcommittee on Permissible Dose from External Sources of the Nation-

al Committee on Radiation Protection had decided upon the necessity of changing the permissible dose from 0.1 r/day to 0.3 r/week as measured in air. This was first presented to the Tri-Partite Conference in Chalk River in 1949, and was adopted. While the report of this subcommittee has not yet been published, its influence has already been felt.

Thus far the National Committee on Radiation Protection has completed ten recommended codes, which have been published as National Bureau of Standards Handbooks. Others are in press or in various stages of preparation. These codes represent what was felt to be the most authoritative technical information on the subject at the time, and the Committee does not concern itself with their promulgation, legal or otherwise. In fact, the Committee has held from the outset, as it does today, that the formulation of radiation safety codes into legal statutes by national or state bodies is an unwise procedure. It believes that laws on radiation protection limit flexibility and make it difficult to take advantage of the rapid developments in the field.

On the other hand, it is worth noting that over the past twenty years most court decisions involving matters of radiation safety have been settled one way or the other on the basis of the recommendations published by this Committee. This is both gratifying and sobering insofar as the Committee is concerned—sobering because it demonstates the utmost necessity of being always as right and as fair as the data and information of the day permit.

APPENDIX

Subcommittees and Reports of the National Committee on Radiation Protection

Subcommittees

1. Permissible Dose from External Sources. G. Failla, Chairman.

The final report by this group is essentially completed. The more troublesome points on basic philosophy, particularly those regarding genetics, seem to have been satisfactorily resolved; and it is now a matter of formulating the material into final shape.

2. Permissible Internal Dose. K. Z. Morgan, Chairman.

The final report of this subcommittee was published in March, 1953 (H 52, see list below). This is necessarily a very detailed and complicated report. It may be possible that in view of an expected more general acceptance of the concepts and numerical values, a future edition can be somewhat simplified.

3. X-rays up to Two Million Volts. H. O. Wyckoff, Chairman.

The first report of this subcommittee was published in March, 1949 (H 41, see list below), and more than 50,000 copies have been distributed. One relatively minor change in the report has been released to the radiological journals. A revision of this report is now being started.

4. Heavy Ionizing Particles (Neutrons, Protons, and Heavier). D. Cowie, Chairman.

A report on neutron protection has been in preparation for over three years. Here, again, the basic approach was very difficult, since any evaluation of the situation was closely allied with the problem of measurements in the different energy regions.

5. Electrons, Gamma Rays, and X-rays above Two Million Volts. H. W. Koch, Chairman.

A report by this subcommittee dealing with problems of protection in the multimillion volt range from radiations produced by betatrons and synchrotrons is now completed; draft copies were widely circulated for comment. The report includes considerable basic information on questions of high energy photons and electron measurements; it is issued as National Bureau of Standards Handbook 55.

6. Handling of Radioactive Isotopes and Fission Products. H. M. Parker, Chairman.

The first report of this subcommittee was published in September, 1949 (H 42, see list below), and more than 20,000 copies have been distributed. There are various items included in this report that have since been taken up in more detail in subsequent Handbooks prepared by other subcommittees. When it is revised, it will probably include material presently contained in other Handbooks.

7. Radiological Monitoring Methods and Instruments. H. L. Andrews, Chairman.

The report of this subcommittee was re-

leased in April, 1952 (H 51, see list below), and some 8,000 copies have been distributed. Although no immediate revision is contemplated, material and data are being gathered for a future revision and extension. The scope of this program is limited mainly to questions of instrumentation and measurements necessary to implement the recommendations of the other subcommittees. It is not proposed to develop an instrument manual.

8. Waste Disposal and Decontamination. J. H. Jensen, Chairman.

This subcommittee has been working actively for about three years. A report on control and removal of radioactive contamination (H 48) was printed in December, 1951, and so far about 10,000 copies have been distributed. The subcommittee has also released a report on the waste disposal of phosphorus-32 and iodine-131 (H 49), of which 8,000 copies have been sold. A report on the disposal of carbon-14 is published (H 53), and reports on the disposal of radioactive materials in soil and at sea are progressing satisfactorily. Work is also being done on the disposal of other isotopes.

9. Protection against Radiations from Radium, Cobalt-60, and Cesium-137 Encapsulated Sources. C. B. Braestrup, Chairman.

The old Handbook on radium protection was last revised in 1935 and issued as National Bureau of Standards Handbook 23. Extensive changes have taken place since that time with the result that this Handbook is now largely out of date. It has now been completely revised and extended to include protection from cobalt-60 and cesium-137 in addition to radium. This new revision (in press, H 54) includes basic shielding data and codes of practice directed mainly toward medical applications. Industrial applications will probably not be dealt with as such, but the general framework will be applicable to non-medical problems.

Safe Handling of Cadavers Containing Radioactive Isotopes (ad hoc). E. H. Quimby, Chairman.

An ad hoc committee has been set up to investigate the problems of radiation protection in connection with the handling of contaminated human bodies. This has considerable importance, not only from the point of view of hospital practices and morticians, but also for civil defense. A report has been published (H 56, see following list).

Reports

NBS Handbook Number	*Title*	*Subcommittee*	*Price*
H 15	X-ray Protection (1931). Superseded by H 20, in turn superseded by H 41.	—	—
H 18	Radium Protection for Amounts up to 300 Milligrams (1934). Superseded by H 23.	—	—
H 20	X-ray Protection (1936). Superseded by H 41.	—	—
H 23	Radium Protection (Aug. 25, 1938).	—	20¢
H 41	Medical X-ray Protection up to Two Million Volts (March 30, 1949).	3	20¢
H 42	Safe Handling of Radioactive Isotopes (Sept., 1949).	6	15¢
H 48	Control and Removal of Radioactive Contamination in Laboratories (Dec. 15, 1951).	8	15¢
H 49	Recommendations for the Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users (Nov. 2, 1951).	8	20¢
H 51	Radiological Monitoring Methods and Instruments (April 7, 1952).	7	15¢
H 52	Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water (March 20, 1953).	2	20¢
H 53	Recommendations for the Disposal of Carbon-14 Wastes (Oct. 26, 1953).	8	—
H 54	Protection against Radiations from Radium, Cobalt-60, and Cesium-137 Encapsulated Sources (*in press*). Supersedes H 23.	9	—
H 55	Personnel Protection for Betatron-Synchrotron Radiations up to 100 Million Electron Volts (March, 1954).	5	—
H 56	Safe Handling of Cadavers Containing Radioactive Isotopes (Oct. 26, 1953).		—

Blood Counts (ad hoc). R. S. Stone, Chairman.

It has long been suspected that complete and

detailed blood studies as an indication of radiation damage are of questionable value. Since blood counts have been recommended in past Handbooks, it is important to review the whole question. In view of the discussions presented in Stockholm in September, 1952, the work of this subcommittee is largely crystallized and it seems probable that blood counts will not be required in the future except under very special circumstances. A report will be issued.

Where the price is stated above, the Handbook can be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The prices quoted are for delivery to addressees in the United States and its territories and possessions and in certain foreign countries that extend the franking privilege. In the case of all other countries, one-third the cost of the publication should be added to cover postage. Remittances should be made either by coupons (obtainable from the Superintendent of Documents in sets of 20 for $1.00 and good until used), or by check or money order payable to the "Superintendent of Documents, Government Printing Office" and sent to him with the order.

Atomic and Radiation Physics Division
National Bureau of Standards
Washington 25, D. C.

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14. State of California, Division of Industrial Safety, General Industry Safety Orders, Register 18, No. 8, 12-19-49, p. 432.105.
15. Commonwealth of Massachusetts, House No. 82 and 83, Jan. 1951.
16. National Committee on Radiation Protection. Lauriston S. Taylor, Chairman, National Bureau of Standards, Washington 25, D. C.
17. An Act for the Development and Control of Atomic Energy. Public Law 585, 79th Congress. Chap. 724, Second Session. (S. 1717.)

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Thirty-seventh Annual Meeting: 1955, to be announced.

EDITORIAL

RADIOACTIVE GOLD (Au^{198}) IN THE TREATMENT OF CANCER

OF THE many radioactive isotopes which have been made available from the nuclear reactors, radioactive gold (Au^{198}) has emerged as one of great promise. It can be used for interstitial and intracavitary application due to its chemical inertness, its availability in a chemically pure state, and its short half-life of 2.69 days.

The fact that radioactive gold can be prepared in a colloidal state with controllable particle size imparts desirable properties to it not possessed by other agents, such as roentgen rays, radium, or some of the artificially radiactive substances used to deliver ionizing radiations. Its emission spectrum contains a beta particle of 0.98 mev. energy and two gamma rays of 0.12 and 0.41 mev. energies respectively. The local effect in tissue is well confined since approximately 95 per cent of the radiation is contributed by the beta particles which have a maximum range in water of 3.8 mm. It is to be expected then that the radiation effect is almost totally exerted in the first few millimeters of tissue. This has been confirmed by several investigators. The gamma component of the radiation from radioactive gold, which comprises 5 per cent of the total, permits ease in monitoring and serves to make the dosage more uniform. It proves troublesome, however, in personnel exposure and may be responsible for a significant and as yet poorly understood total body irradiation of the patient.

Radioactive gold has been employed during the past decade in several ways, including intravenous, intracavitary and interstitial methods of administration. One of its most important uses has been in the palliative management of peritoneal and pleural effusions of neoplastic origin where it is injected in the form of a collodial solution. It has not supplanted roentgen therapy in this regard but promises to be a useful adjuvant in properly selected cases.

In dealing with peritoneal effusions colloidal radioactive gold has the advantage over roentgen therapy of producing less radiation sickness and it is less injurious to the intestine. Andrews, Root, Kerman and Bigelow[1] state that these patients, in order to be favorable candidates for colloidal radioactive gold therapy, should be in good general condition and the effusion should be the cause of their presenting symptoms, *i.e.*, the necessity of frequent paracenteses. They further point out that the presence of tumor masses may preclude the use of radioactive gold. Generally, it is thought that roentgen therapy is of greater benefit in this latter situation. It has been repeatedly emphasized by many authors that the site of origin of the malignant neoplasm responsible for the effusion has little effect on the efficacy of this form of therapy.

Pleural effusions can be more successfully controlled with roentgen therapy than those of peritoneal origin. This usually implies, however, that the underlying lung parenchyma must be sacrificed due to the incident fibrosis. The injection of colloidal radioactive gold in the pleural space has the advantage that the effect of its beta radiation is limited to the lining surfaces and thus the lung can be functionally preserved. It is assumed, of course, that no significant disease is present in the underlying lung.

[1] Andrews, G. A., Root, S. W., Kerman, H. D., and Bigelow, R. R. Intracavitary colloidal radiogold in treatment of effusions caused by malignant neoplasms. *Ann. Surg.*, 1953, *137*, 375–381.

The preservation of lung tissue is extremely important, particularly in patients with their respiratory function seriously curtailed by the disease process itself.

It should be emphasized that peritoneal and pleural adhesions producing loculations may lead to serious localized overdosage if they are not recognized. The body cavity into which the isotope is injected can be conveniently checked with a portable survey meter and, if any serious localization is present, the material should be withdrawn.

Reactions consisting of nausea, vomiting, weakness and malaise as reported by Andrews, Root, Kerman and Bigelow[1] are usually mild in degree and persist for two or three days. They are more severe with intraperitoneal administration of the colloidal radioactive gold than when the substance is given intrapleurally. Diarrhea and pleuritis are occasionally encountered. Hematopoietic depression is not serious and is of transitory nature followed by prompt recovery. There is some controversy as to the actual extent of bone marrow damage caused by radioactive gold but most of the evidence indicates that it is not of serious proportions. That percentage of the isotope reaching the circulation is deposited in the liver and spleen or is excreted in the urine. These values are not of sufficient magnitude to cause concern.

Due to its finite particle size, colloidal radioactive gold is phagocytosed and deposited in the reticuloendothelial system, *i.e.*, principally in the liver, spleen and bone marrow, and to a lesser extent in the lung. Zilversmit, Boyd and Brucer,[2] using colloidal radioactive gold, have shown that by enlarging the particle size of the material the blood clearance rate is increased. Eighty to 90 per cent of the injected dose was removed by the liver and spleen, the spleen taking up one-half to one-fifth as much as the liver per gram of tissue. The bone marrow and lymph nodes were much less active, while the kidney and lung exhibited the same activity as the bone marrow. The interval between injection and deposition in these areas depended upon the route of administration and the size of the colloidal particle.

The mechanism of colloidal radioactive gold therapy in controlling effusion is not thoroughly understood. Andrews, Root and Kinsely[3] suggested the following possible actions: (1) fibrosis of tumor surfaces; (2) diminution of lymphatic drainage by irradiation of the lymph node substance; (3) partial inflammatory obliteration of the serous cavity, and (4) an unknown action on uninvolved portions of the cavity surface.

Knisely and Andrews,[4] in studying the pathological changes following the injection of colloidal radioactive gold into the body cavities, found that most of the particles were absorbed unevenly by the cavity surfaces. Some of them were phagocytosed and only a fraction remained in the colloidal suspension in the fluid. These authors noted inconsistent deposition in the regional lymph nodes.

It has been suggested by many authors that colloidal radioactive gold may be used prophylactically in carcinoma of the ovary where spilling of cyst contents occurs at the time of operation or where implant metastases are observed. This may prove to be one of the most significant contributions in the use of this form of therapy. Careful evaluation must be awaited, however, before this can be accepted. Occurrence of irreversible sequelae may render the method prohibitive.

The most significant interstitial application of colloidal radioactive gold has been introduced by Kerr, Flocks, Elkins and Culp[5] in the treatment of moderately ad-

[2] Zilversmit, D. B., Boyd, G. A., and Brucer, M. Effect of particle size on blood clearance and tissue distribution of radioactive gold colloids. *J. Lab. & Clin. Med.*, 1952, *40*, 255–260.

[3] Andrews, G. A., Root, S. W., and Knisely, R. M. Metabolism and distribution of colloidal Au^{198} injected into serous cavities for treatment of effusions associated with malignant neoplasms. *Cancer*, 1953, *6*, 294–302.

[4] Knisely, R. M., and Andrews, G. A. Pathological changes following intracavitary therapy with colloidal Au^{198}. *Cancer*, 1953, *6*, 303–312.

[5] Kerr, H. D., Flocks, R. H., Elkins, H. B., and Culp, D. Treatment of moderately advanced carcinoma of prostate with radioactive gold. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., June, 1953, *69*, 969–977.

vanced carcinoma of the prostate. This lesion has remained difficult to control in the past because of its clinical silence. While the cure rate of malignant tumors of other organs has been increased, that of carcinoma of the prostate has remained about the same. In the group of patients which are surgically incurable due to contiguous spread but in which distant metastases have not yet occurred this method holds promise. Dosage is assessed according to the weight of the gland and on the basis of a millicurie per gram ratio. Hyaluronidase is used in the diluent to enhance uniform local distribution, and epinephrine is added to minimize circulatory absorption. A specially designed syringe is employed to inject the colloidal suspension under pressure which further ensures homogeneous distribution. Significant complications have been few. Rectal irritation and ulceration have been encountered in the authors' early experience but alterations in technique have obviated these to a large extent. Despite detectable counts of radioactivity over the liver and spleen, no instance of clinical, functional or pathological liver damage has been observed. The authors report a prompt and rapid decrease in the size of the palpable tumor and its softening in about 98 per cent of the cases three weeks following injection.

Sherman, Bonebrake and Allen[6] have reported on their use of radioactive colloidal gold interstitially in the treatment of pelvic cancer, and it is their impression that these lesions can be more effectively controlled by adding this procedure to the existing methods.

[6] Sherman, A. I., Bonebrake, M., and Allen, W. M. Application of radioactive colloidal gold in treatment of pelvic cancer. Am. J. Roentgenol. & Rad. Therapy, 1951, *66*, 624–638.

Myers, Colmery and McLellon[7] have employed radioactive gold wires as gamma-ray emitters for permanent implants and removable linear sources. They feel that Au^{198} used in this manner has many advantages over radon used similarly.

Protection of personnel in treating with radioactive gold has been met without great difficulty, using barriers of lead where practicable and by minimizing the time required to perform the operative procedures for its application. Most investigators report that exposure of personnel has consistently been kept below tolerance levels.

Ter-Pogossian and Sherman,[8] in an excellent and comprehensive article, have outlined in detail the necessary laboratory facilities and equipment required in receiving, diluting, administering and monitoring radioactive gold. According to the specifications of the U. S. Atomic Energy Commission[9] any patient exhibiting more than 30 mc. of radioactivity must be kept in the hospital until his activity has diminished to this level.

All in all, it may be said that the results of studies employing radioactive gold have been encouraging in the management of neoplastic effusions and in the control of carcinoma of the prostate. Other aspects of irradiation with this agent are more distinctly in a research phase and further experience is necessary before definite evaluation can be made.

Kenneth L. Krabbenhoft, M.D.

[7] Myers, W. G., Colmery, B. H., Jr., and McLellon, W. M Radioactive gold-198 for gamma radiation therapy. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., Aug., 1953, *70*, 258–273.

[8] Ter-Pogossian, M., and Sherman, A. I. Handling of radioactive gold for therapeutic purposes. *Nucleonics*, 1952, No. 3, *10*, 23–27.

[9] Isotopics: Announcement of the Isotope Division, U. S. Atomic Energy Commission 2, 3. July, 1952.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Shoreham Hotel, Washington, D.C., Sept. 21–24, 1954.

American Radium Society
Secretary, Dr. R. E. Fricke, Mayo Clinic, Rochester, Minn. Annual meeting: 1955, to be announced.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: 1954, to be announced.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich. Annual meeting: San Francisco, Calif., June 21–25, 1954.

Fifth Inter-American Congress of Radiology
General Secretary, Dr. Eugene P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pa. Meets at Shoreham Hotel, Washington, D. C., April 24–30, 1955.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N.Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. Elbert K. Lewis, 6337 S. Harvard Ave., Chicago, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

Cleveland Radiological Society
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

Colorado Radiological Society
Secretary, Dr. Parker Allen, Children's Hospital, Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday October and April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. O. H. Grunow, 650 Fifth Ave., Fort Worth, Texas. Meets monthly, third Monday, at Greater Fort Worth International Airport at 6:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. F. Lang, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, October to May, at Wayne County Medical Society Building.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. H. G. Reaves, Medical Arts Bldg., Sarasota, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. Robert M. Tankesley, 218 Doctors Bldg., Atlanta, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Greater Miami Radiological Society
Secretary, Dr. R. D. Shapiro, 541 Lincoln Rd., Miami Beach, Fla. Meets monthly at various South Florida Hospitals.

Houston Radiological Society
Secretary, Dr. Harry Fishbein, 324 Medical Arts Bldg., Houston 2, Texas. Meets fourth Monday each month at Hermann Hospital.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

Iowa Radiological Society
Secretary, Dr. James T. McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

Kansas Radiological Society
Secretary, Dr. Willis L. Beeler, M.D., 700 Kansas Ave., Topeka, Kansas. Meets in spring with State Medical Society, and in winter on call.

Kentucky Radiological Society
Secretary, Dr. David Shapiro, 323 East Chestnut St., Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Solomon Maranov, 1450 51st St., Brooklyn 19, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. George Jacobson, 1200 N. State St., Los Angeles 33, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Maine Radiological Society
Secretary, Dr. Jack Spencer, Maine General Hospital, Portland 4, Maine. Meets in early spring, June and fall.

Maryland Radiological Society
Secretary-Treasurer, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Maryland.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. John R. Hodgson, Mayo Clinic, Rochester, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 117 N. President St., Jackson, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

Montana Radiological Society
Secretary, Dr. Grant P. Raitt, Suite 413 Medical Arts Bldg., Billings, Montana. Meets at least once a year.

Nassau Radiological Society
Secretary, Dr. Frank Huber, Hempstead, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. J. R. Freid, 1049 Park Ave., New York 28, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. W. C. Sternbergh, Charlotte Memorial Hospital, Charlotte, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

Northeastern New York Radiological Society
Secretary, Dr. D. H. Baxter, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April.

Northern California Radiological Society
Secretary, Dr. H. B. Stewart, 2920 Capitol Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

Ohio State Radiological Society
Secretary, Dr. M. M. Thompson, 316 Michigan St., Toledo, Ohio. Annual meeting, Toledo, Ohio, May 22 and 23, 1954.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. J. W. Loomis, 919 Taylor St. Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse 416 Pine St., Williamsport. Next annual meeting at Bedford Springs Hotel, Bedford, Penna., May 14 and 15, 1954.

Philadelphia Roentgen Ray Society
Secretary, Dr. H. M. Stauffer, Temple University Hospital, Philadelphia 40, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets 6:00 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Connecticut Medical Society
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

Radiological Section, Medical Society of the District of Columbia
Secretary, Dr. A. C. Wyman, 5445—28th St., N.W., Washington, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Chapin Hawley, 927 Carew Tower, Cincinnati 2, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Dr. P. S. Arthur, Young Hotel Bldg., Honolulu 13, T. H. Meets third Friday of each month at a place designated by the Secretary.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of Louisiana
Secretary, Dr. J. T. Brierre, 700 Audubon Bldg., New Orleans. Meets annually during Louisiana State Medical Society Meeting.

Radiological Society of New Jersey
Secretary, Dr. Salomon Silvera, 921 Bergen Ave., Jersey City, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

Radiological Society of Southern California
Secretary, Dr. Donald R. Laing, 65 N. Madison Ave., Pasadena 1, Calif.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga. Meets first Thursday of each month at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Henry H. Forsyth, Jr., 40 Meigs St., Rochester, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 7, Colo.

St. Louis Society of Radiologists
Secretary, Dr. W. B. Seaman, 510 South Kingshighway, St. Louis 10, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. C. W. Bruner, 2456 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

Section on Radiology. California Medical Association
Secretary, Dr. H. R. Morris, 1027 "D" St., San Bernardino, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Bay Radiological Society
Secretary, Dr. J. J. McCort, Santa Clara County Hospital, San Jose, Calif. Meets second Wednesday each month.

South Carolina Radiological Society
Secretary, Dr. William A. Klauber, Self Memorial Hospital, Greenwood, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. G. K. Henshall, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets fourth Wednesday in January, March, May, September and November at Holy Cross Hospital.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Eva L. Gilbertson, 1317 Marion St., Seattle 4, Wash. Meets fourth Monday of each month from September through May at 610 Pine St., Seattle.

West Virginia Radiological Society
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

Westchester Radiological Society
Secretary, Dr. C. G. Huntington, 170 Maple Ave., White Plains, N. Y. Meets on third Tuesdays of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. W. W. Moir, 309 Geele Ave., Sheboygan, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Wm. W. Saunders, Veterans Administration Hospital, San Francisco 21, Calif. Meets monthly, third Thursday, at 7:45 P.M., Lane Hall, Stanford University Hospital.

Cuba, Mexico, Puerto Rico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

Asociación Puertorriqueña de Radiología
Secretary, Dr. Rafael A. Blanes, Ave. Ponce de Leon 1175, Santurce, P. R.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. D. L. McRae, Suite 305, 1555 Summerhill Avenue, Montreal 25, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

College of Radiologists (Australia and New Zealand)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral. Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6º piso, Bogota, Colombia. Meets last Thursday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, du Littoral Méditerranéen, du Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IXe, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

Wroclaw Section Polish Society of Radiology
Secretary, Dr. R. Marciniak, Akad. Medyczna Wrocław, 68 Curie-Skłodowska St., Wrocław, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wrocław.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

Deutsche Röntgen-Gesellschaft
Secretary, Dr. med. Peter Kröker, Evangelisches Krankenhaus, Huyssens Stiftung, (22a) Essen. Annual meeting, Sept. 5–8, 1954, Wiesbaden, Germany.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

SEVENTH INTERNATIONAL CONGRESS OF RADIOLOGY, COPENHAGEN, 1953

The Seventh International Congress of Radiology was held in Copenhagen, Denmark, July 19–26, 1953, Professor P. Flemming Møller was President and Professor Flemming Nørgaard was Secretary-General. The Honorary President was Professor Niels Bohr, the Danish physicist who received the Nobel Prize in 1922 for his work on the atom. The Congress was officially opened on Sunday afternoon, July 19, in the presence of King Frederik IX.

A large, generally excellent scientific program was provided in which were many contributions from this country. The section meetings were held in two different areas which were separated by a three or four minute taxi ride. At times, as many as twelve section meetings were in progress at the same moment. This is an indication of the scope and importance of the material presented in the various papers.

A large scientific exhibit was available. Of particular interest were transverse body section roentgenograms after the retroperitoneal insufflation of oxygen, by Professor Vallebona of Milan, Italy.

The technical exhibit was interesting. The greater part of the apparatus on display was made on the other side of the Atlantic. Equipment for body section roentgenography in both horizontal and erect positions has been developed which seems to be far in advance of similar equipment made in this country. Apparatus for electrically controlled automatic intravascular injection of opaque materials which makes it unnecessary for an individual to stand close to the beam of roentgen rays is being made in Sweden. Rapid film shifting machines for angiocardiography, up to 12 films per second, are now in use. Roentgen-ray generating equipment using three phase current at 150 kv. has been produced. With this machine, Kjellberg, at the Carolinska Institute, is making films of infants' chests in as little as 0.004 second.

The material included in these three categories was many times as much as one individual could assimilate.

The total enrollment of the Congress was 3,526, which includes all categories of membership. The hotel facilities of Copenhagen were quite inadequate to take care of so many visitors. However, the Congress was well organized and well run by the Danish Committee. The task of organizing, running and concluding the business affairs of an International Congress is indeed large. The Danish officials deserve the thanks of all radiologists.

A proposal was discussed at the Sixth International Congress in London to form an International Federation of Radiological Societies to serve as the parent organization of these Congresses. This proposal was introduced in concrete form by the Danish Delegation at the Copenhagen Congress. It was disapproved by the International Committee. However, the International Congress of Radiology has three important committees: (1) The International Commission on Radiological Units, (2) The International Commission on Radiological Protection, and (3) The International Commission on Stage Grouping in Cancer and the Presentation of Results of Treatment of Cancer. The importance of continuation and continuity of the work of these Commissions and methods of financing their work were discussed. It was therefore proposed to establish an *International Society of Radiology* which would function under the International Congress, not over it, the purpose of which would be to provide means for continuity of the work of these commissions between congresses. All national radiological societies would be invited to join, and each would be asked to pay the equivalent in its own national currency of one-quarter of a United States dollar ($0.25) per member per year. This money would be used solely for the support of the work of the International Commissions. This proposal was approved by all the national delegations except two, the Philippines and the United States of America. A committee was appointed with members from six countries

to prepare a constitution and by-laws for this society. This committee as yet has not submitted a report.

The work of the International Commissions is of particular importance. They have given us such units as the roentgen and the rad. They provide a scientific language which permits international coordination of thought, discussion and comparison of results. The members of these commissions work hard through long hours for several days before the meetings. The financing of this work is a problem separate from that of the Congress itself. It seems to some of us that the subscription fees paid by members of the Congress should be used, not for social affairs, but solely for the expense of the scientific part of the meeting. The members of the Congress should be and, we believe, are willing to pay for tickets to dinners, sightseeing trips, etc. Consequently it seems highly desirable to work out some other method of financing the International Commissions. Possibly this could be done by revising the Constitution of the Congress itself and requesting a subscription for this purpose from all national societies which send delegates to the Congress, rather than by organizing a new society under the Congress. However, the proposal for the new International Society of Radiology was passed almost unanimously in the International Committee and a formal proposal will undoubtedly be submitted to our national societies at a later date.

A proposal to change the intervals between the International Congresses of Radiology from three to four years was introduced by the Delegation from Mexico (as in 1950), was supported by the Delegation from the United States, and was lost in the International Committee by only two votes.

The invitation of the Delegation from Mexico to hold the eighth International Congress in Mexico City was unanimously accepted. The President is Dr. Manuel F. Madrazo. This Congress will be held in Mexico City during 1956, but the exact date has not been decided.

A large number of international medical organizations are now in existence and appear to be functioning successfully. The "Congress for the International Organization of Medical Sciences" was set up several years ago to correlate the activities of these societies. The membership, according to the latest available information, was comprised of 54 international organizations, one of which is the International Congress of Radiology.

In the United States four important national meetings of radiological organizations and of radiological sections of State Medical Associations occur each year. Many local radiological societies hold meetings at frequent intervals. It is therefore a little difficult for us to appreciate the importance of the International Congresses in the lives of our foreign colleagues, particularly those in smaller countries. Because of the increasing number of members and complexity of the meetings, it is increasingly difficult to find a city which can offer sufficient hotel and other accommodations. Nevertheless, International Congresses of Radiology will continue to be held. They deserve the support and cooperation of our national radiological societies.

During the Congress in Copenhagen, the Danish Radiological Society awarded Honorary Membership to Dr. Arthur C. Christie, Washington, D. C., Past President of the Fifth International Congress of Radiology, which was held in Chicago, Illinois, in 1937.

Ross Golden, M.D.

AMERICAN COLLEGE OF RADIOLOGY

The following officers were elected at the annual meeting of the American College of Radiology held on February 4 and 5, 1954, in Chicago, Illinois: Dr. Howard P. Doub, Detroit, Michigan, *President;* Dr. Ira H. Lockwood, Kansas City, Missouri, re-elected *Chairman of the Board;* Dr. Webster H. Brown, Baltimore, Maryland,

Vice President; Dr. Kenneth D. A. Allen, Denver, Colorado, new *Chancellor* for 4 year term; Dr. Leslie K. Sycamore, Hanover, New Hampshire, new *Chancellor* for 4 year term; Dr. Fred O. Coe, Washington, D. C., re-elected for one year as *Chancellor* representing the American Roentgen Ray Society. He had been filling the unexpired term for Dr. Joshua C. Dickinson, Tampa, Florida; Dr. Joseph C. Bell, Louisville, Kentucky, re-elected for additional 3 years on the *Board of Chancellors;* Dr. Arthur C. Singleton, Toronto, Ontario, re-elected for an additional 2 years as *Chancellor* representing the Canadian Association of Radiologists; Dr. Earl E. Barth, Chicago, Illinois, *Treasurer.*

ROCHESTER ROENTGEN RAY SOCIETY

At a recent meeting of the Rochester (New York) Roentgen Ray Society the following officers were elected for the coming year: *President,* Dr. Robert J. Bloor; *Vice President,* Dr. A. Gordon Ide; *Secretary-Treasurer,* Dr. Henry H. Forsyth, Jr., 40 Meigs St., Rochester, N. Y. The Society meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

ISOTOPE TECHNIQUE COURSES

Three basic isotope technique courses and three special courses will constitute the summer program of the Special Training Division of the Oak Ridge Institute of Nuclear Studies.

A new offering of the Division is a two-week course on radioactivity designed for teachers in secondary schools and teachers colleges. This course, which begins on June 7, 1954, will consist of background lectures in physics and radioactivity, together with a demonstration of all experiments outlined in the recent Atomic Energy Commission booklet, "Laboratory Experiments with Radioisotopes." Emphasis throughout the course will be on the technique of using radioisotopes in classroom demonstrations and in laboratory work. As many as 60 individuals will be accepted for the course.

The Division will open a one-week advanced course in Applied Instrumentation beginning on June 28, 1954. This course will consist of a group of lectures on instrumentation techniques and demonstrations of modern instruments by technical representatives of the manufacturers. Each manufacturer will be asked to supply instruments and demonstrate techniques involved in a variety of radioisotope problems.

An advanced course in radioisotope applications in biochemistry will be held September 6–17, 1954. This is the second such course to be given by the Division.

Basic courses of one-month duration will begin on June 14, July 12, and August 9, 1954.

Registration fee for all courses is $25.00.

The Special Training Division has recently occupied enlarged laboratory and lecture room space in connection with the building of an adjoining structure to house the Technical Library of the Oak Ridge Institute of Nuclear Studies. The main lecture room and demonstration facilities now enable the Division to accept as many as 100 participants in nonlaboratory courses.

Application blanks and additional information on the courses may be obtained from the Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

AMERICAN SOCIETY OF X-RAY TECHNICIANS

The twenty-sixth annual convention of the American Society of X-Ray Technicians will be held in Miami, Florida, May 16 through May 20, 1954, with headquarters at the McAllister and Columbus Hotels. Plans are being formulated for an interesting and informative educational program. There will be lectures, refresher courses, and exhibits, and essay awards will be presented to technicians submitting manuscripts. In addition, many and varied social

events have been arranged by the entertainment committees.

NEW YORK ROENTGEN SOCIETY

The Ross Golden Lecture of Columbia University will be given before a combined meeting of the New York Roentgen Society in affiliation with the New York Academy of Medicine on Monday evening, April 19, 1954, at 8:30 P.M. The speaker on this occasion will be Dr. Leo G. Rigler, Professor and Chairman of the Department of Radiology, University of Minnesota, Minneapolis, Minnesota. Dr. Rigler's subject is "Roentgen Observations of the Natural History of Carcinoma of the Lung."

FIFTH INTER-AMERICAN CONGRESS OF RADIOLOGY

The Fifth Inter-American Congress of Radiology will hold its next meeting in the United States at the Shoreham Hotel, Washington, D. C., April 24–30, 1955, The General Secretary is Dr. Eugene P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pennsylvania. More detailed notices will appear in future issues of the JOURNAL.

AMERICAN BOARD OF RADIOLOGY

The final date for filing applications for the Fall, 1954, examination by the American Board of Radiology is May 1, 1954. The examination will be held during the week of September 13, 1954, in Washington, D. C.

B. R. KIRKLIN, M.D., *Secretary*
Mayo Clinic
Rochester, Minn.

Vol. 71, No. 4

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor; T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Petit-Dutaillis, D., Guiot, G., and Berdet, H. Anévrismes cirsoïdes et anévrismes artério-veineux de l'encéphale d'après dix-neuf cas; considérations anatomiques, cliniques et radiologiques. (Cirsoid and arteriovenous aneurysms of the brain; anatomic, clinical and roentgenologic considerations on the basis of 19 cases.) *Presse méd.*, June 24, 1953, *61*, 901–905.

Cirsoid, arteriovenous or arterial aneurysms of the brain have no characteristic clinical picture. The diagnosis should be considered in all cases of subarachnoid hemorrhage, especially when alternating with focal epileptic fits. The suspicion is strengthened if angiomas are seen on the skin or mucous membrane (5 of 19 cases). The diagnosis should also be considered in all cases of spontaneous intracerebral hematoma in a young person.

Skull roentgenograms only rarely show changes which are diagnostic of these conditions. In one case gross vascular imprints associated with condensation of the vault was noted, similar to the alterations seen in meningiomas. Calcifications in the walls of the aneurysm, although frequently observed histologically, rarely manifest themselves roentgenographically; they were seen in 1 of the 19 cases in which they suggested the diagnosis of oligodendrocytoma.

Arteriography is the basic study for these lesions. Lateral views are insufficient as the lesion may be injected through the carotid on the opposite side because of the richness of the collateral circulation; this occurred in 1 case. Arteriography may be combined with ventriculography in order to study the connections of the pocket with the ventricle. Localization of small vascular anomalies may require a repeat arteriogram with centering on the lesion and a precision similar to that used in localizing foreign bodies. If carotid arteriography does not reveal the lesion, one must have recourse to vertebral arteriography; only the latter permits visualization of aneurysms of the posterior fossa.

Cirsoid aneurysm presents itself as an oval or square image with sharp contours or as a more or less extensive shadow with diffuse contours which appears during the arterial phase. Usually one or several tortuous, obliterated arteries are noted to end at the lesion. In arteriovenous aneurysm, the most striking finding is the injection, at the arterial stage, of a cerebral vein. Only by scrutinizing the immediate surrounding of this vein is a vascular shadow found, ranging in size from a grain kernel to a pea. This small anomaly, which may represent an angioma or arteriolar tuft, must be localized with precision so that it may be found at operation.

Finally, arteriography may demonstrate one or several venous or arterial pedicles of the lesion which may help in planning surgery. The success of excision depends largely on this preoperative study. —*Jonas Brachfeld, M.D.*

Mifka, P. Über die Angiographie bei zerebralen Insulten. (Angiography in cerebral accidents.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, June, 1953, *78*, 647–656.

Since cerebral angiography causes fewer reactions than ventriculography the method was used for the examination of patients with cerebral vascular accidents. Ten cubic centimeters of a 35 per cent diiodon or umbradil solution was injected, followed by two additional injections, so that a total of 30 cc. was usually employed. Shock-like side reactions were observed, apparently due to transient spastic occlusion of the carotid artery or its main branches on the injected side. These could be avoided by injecting 100 mg. of ronicol in 20 cc. of normal saline before injection of the opaque medium. About 10 per cent of the patients with a clinical diagnosis of cerebral vascular accident suffer in reality from some other disease, such as tumor, subdural hematoma or cerebral aneurysm.

The roentgenologic evaluation of cerebral vascular changes is difficult because there are none of the distinctive findings as noted with other lesions of the brain. Vascular changes are diffuse, and the border between normal and pathologic vascular shadows is indefinite. The cause of the vascular changes cannot be determined by angiographic study since etiologically different lesions produce the same roentgen findings. Significant angiographic changes may be observed in the cervical part of the carotid, in the syphon, and in the endocranial vascular ramifications. They consist mainly of tortuosity considerable variation of the caliber of the involved vessels, and small filling defects. Endocranial vascular changes are of three types. Type I is marked by abnormally coarse looping of the larger arterial branches, usually with a wide lumen, and by conspicuous paucity of the vascular shadows in the periphery. Type II is characterized by an abnormal increase of vascular shadows, with complete or partial filling of the vertebral artery from the carotid. Type III is defined by extensive sclerotic changes affecting many of the visible vessels, with variations of caliber, coarsening of loops and beaded appearance of the vessels due to many small filling defects.

As a rule, cerebral accidents occur in small vessels which are not accessible to angiography. Consequently the site of the injury and the extent of the damage cannot be determined by this mehod. Only the general vascular disease can be demonstrated angiographically.—*Albert Oppenheimer, M.D.*

Leader, S. A. Accidental visualization of the ventricles months after the intracranial in-

jection of thorotrast. *Radiology*, May, 1953, *60*, 651–655.

A case is presented in which the lateral ventricles and the third ventricle were visualized about eight months after injection of thorotrast into a cerebral cavity not in communication with the ventricles.

Possible ways are discussed by which the thorotrast may have reached the ventricles, where, possibly, it clung to the walls after loosing its colloidal properties in a closed space.—*Lynne J. Taylor, M.D.*

Smith, C. G. The x-ray appearance and incidence of calcified nodules on the habenular commissure. *Radiology*, May, 1953, *60*, 647–650.

Calcification in the region of the pineal gland is made up not only of the deposits within this gland, but also of calcification in nodules of neuroglia which are prone to occur on the habenular commissure. These latter may be single or multiple, and are seen as a cap-like opacity at the anterior pole of the pineal gland. Frequently these deposits appear crescentric, with their concavity posteriorly, and are constantly separated from the pineal gland by the paper-thin habenular commissure.

Roentgenologically discernible calcification within the pineal gland occurs in about half of all subjects and half of these show calcification on the habenular commissure as well. These calcified nodules do not occur without associated calcification in the pineal gland, and are seen uniformly at any age in adult life.

Anatomic and roentgenographic studies of 123 autopsied brains comprised the material for this investigation.—*William A. Goodrich, Jr., M.D.*

Craig, Winchell McK., Miller, Ross H., and Holman, Colin B. Cysts of the septum pellucidum: interesting case reports. *Proc. Staff Meet., Mayo Clin.*, June 3, 1953, *28*, 330–335.

Cavities of the septum pellucidum are found in about 20 per cent of brains examined postmortem. These cavities may become dilated with fluid and are then classified into three types: (1) non-communicating, in which the walls of the cavity are intact; (2) communicating, in which an opening is present into the lateral or third ventricle, and (3) acquired, as part of a hydrocephalus.

Findings in identical twins, aged two, with cysts of the septum pellucidum are described. Both had severe convulsions and mental retardation. Anteroposterior pneumoencephalograms demonstrated a wide, dense biconcave shadow of the cyst between the outline of the lateral ventricles with little evidence of displacement of the lateral ventricles as indicated by the normal position of the lateral wall.

Roentgenograms made twenty-four hours later showed the lateral ventricles to be returned to normal outline, thus indicating that a communication had developed between the ventricular septum and the cyst. Therefore, radical surgical procedures were not necessary.

Lesions to be differentiated from this deformity are: agenesis of the corpus callosum, tumors of the septum pellucidum, and tumors of the corpus callosum.—*Fay H. Squire, M.D.*

Bakay, Louis, and White, James C. Pneumoencephalography in chromophobe adenomas of the hypophysis. *J. Neurosurg.*, May, 1953, *10*, 284–296.

There is a discrepancy between the clinical signs, the size of the sella and the true size and extension of pituitary adenomas.

Encephalography can assist in determining the size of the tumor. This requires a filling of the third ventricle and the basal cistern. The technique employed is outlined in detail. The cases are classified in three types depending upon size of sella and extent of the tumor.

Pneumoencephalography should be employed in surgical planning and in followup on those requiring roentgen therapy.—*Joseph Levitin, M.D.*

Neck and Chest

Jones, H. Everley. Recurrent parotitis in children. *Arch. Dis. Childhood*, June, 1953, *28*, 182–186.

The author made sialograms on 14 cases of recurrent parotid swelling in children. Thirteen of them showed changes which he thinks are indicative of this disease. No calculus was demonstrated in any case. In 10 cases a spherical dilatation of the finer ducts was seen. In 1 case there was gross dilatation and in 3 the dilatation was intermediate. The main ducts in 4 children showed some dilatation and a tendency to beading.

Recurrent parotitis is a fairly recently recognized entity which was described mainly in adults, but is also being found in children. It is usually diagnosed as mumps or cervical adenitis. It can be differentiated from adenitis by careful physical examination. A reliable history of previous mumps would differentiate it from this condition. The serum amylase has been reported to be elevated up to 150 units in 95 per cent of mumps cases.

Pain, slight to moderate fever and mild leukocytosis were usually noted. Alpha-hemolytic streptococci and pneumococci were isolated from most of the cases.

Treatment consisted of penicillin, massage, or both.—*George L. Sackett, Jr., M.D.*

Candardjis, Georges. Contribution à l'étude radiologique des laryngocèles. (Contribution

to the roentgen study of laryngocele.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, 1953, *34*, 331–335.

The author recently observed at the Institute of Radiology of the University of Lausanne 2 cases of laryngocele and made a detailed study of the roentgenographic and especially laminagraphic appearance of this rather rare condition, which according to Steinmann, has been reported in only about 100 cases.

He describes laryngocele as a dilatation of the appendix of Morgagni's ventricle which is transformed into an anomalous air sac communicating with the laryngeal cavity. It represents an intermediary stage between the congenital hyperplasia of Morgagni's ventricle which occurs in 15 per cent of all humans and the endolaryngeal cysts. It may develop under the influence of various factors, such as cough, vocal strain or muscular efforts into an internal, external or mixed form. One of the author's cases represented the internal and the other the external type.

The external laryngocele is usually well demonstrated in the conventional posteroanterior roentgenogram of the cervical region. It appears as a rounded or slightly oval air pocket of 1 to 2 cm. in diameter, situated laterally to the cornu ossis hyoidei. The internal laryngocele, on the other hand, is more apt to be visualized on a conventional lateral roentgenogram, appearing as a superimposed oval area of increased translucency with the longest diameter running vertically and not rising above the level of the hyoid bone. The best method of examination for both types however, is frontal laminagraphy which permits an excellent study of the form of the laryngocele as well as of its typography and relationship with the laryngeal cavity. The author reproduces some of the frontal laminagrams made in his cases to illustrate this point. In the case with internal laryngocele he also made frontal laminagrams during phonation and while the patient was executing the Valsalva maneuver to obtain confirmation of the aforementioned theory of the causation of the anomaly.—*T. Leucutia, M.D.*

Dérobert, L., and Pizon, P. Les lésions thyro-hyoïdiennes de la strangulation; leur diagnostic radiologique. (Thyrohyoid lesions in strangulation and their roentgen diagnosis.) *Presse méd.*, May 20, 1953, *61*, 731–732.

Of legal importance is the diagnosis of strangulation by the "semi-microradiographic" technique, in particular in cases of putrified or exhumed cadavers.

The principle of this technique is discussed. A maximum of 50 kv. without filtration and a fine grain photographic film are used. The hyoid bone and the thyroid cartilage are dissected very carefully and "semi-microradiographed."

The strangulation often causes either a fracture or a subluxation at the point of articulation between the greater cornu and the body of the hyoid bone. The thyroid cartilage constantly shows a fracture, incomplete in nature, of the superior cornu near its base. Compression fracture of the lateral laminae of the thyroid cartilage is also observed quite frequently. It is of interest to note that it is the right greater cornu of the hyoid bone and the left superior cornu and the left lateral lamina of the thyroid cartilage which are constantly traumatized, indicating that the strangulation has been accomplished by a right-handed person whose thumb brings the pressure on the right side of the hyoid bone whereas the other fingers crush the left side of the thyroid cartilage.—*J. N. Sarian, M.D.*

Melamed, A., and Marck, A. Esophageal obstruction due to Serutan. *J.A.M.A.*, May 23, 1953, *152*, 318–319.

The authors warn of the danger of ingestion of hygroscopic substances without taking sufficient amount of water. With insufficient fluid after the ingestion, the substance becomes swollen and spongy and may cause an obstruction.

A case is reported of obstruction to the lower end of the esophagus after ingestion of serutan. These substances should also be avoided when there is cardiospasm or strictures of the esophagus.—*Joseph Levitin, M.D.*

Totten, R. S., Stout, A. P., Humphreys, G. H., II, and Moore, R. L. Benign tumors and cysts of the esophagus. *J. Thoracic Surg.*, June, 1953, *25*, 606–622.

From both a clinical and pathological standpoint, benign cysts and tumors of the esophagus may be divided into two large groups, the intraluminal polypoid growths and the intramural tumors.

Clinically, these lesions may produce gastrointestinal symptoms of which dysphagia is the most common. Polypoid tumors may produce dramatic regurgitation. None of the leiomyomas in this series led to significant bleeding in contrast to gastric leiomyomas. Respiratory symptoms, including cough dyspnea and choking spells were occasionally present. In a few instances, epigastric or substernal distress was noted.

Esophagoscopy and roentgen examinations constitute the chief means for the diagnosis of these tumors. Roentgenologically, intramural tumors and cysts produce sharply outlined smooth, ovoid or lobulated filling defects in the barium-filled esophagus. In 38 of the 44 cases of intramural tumors in which barium swallows were given, either a filling defect or a mass with esophageal displacement was recorded. Polypoid tumors presented more difficulties in demonstration as is illustrated by the fact that only 8 of 17 cases of polypoid tumors showed some type of filling defect. Esophagoscopy failed to demon-

strate lesions in approximately one-fourth of the cases in which it was used.

The polypoid lessions were treated by resection through an esophagoscope. The intramural tumors were usually enucleated.

Of the 103 benign lesions of the esophagus studied, 40 were intraluminal polypoid lesions and were usually described microscopically as fibrous polyps. The majority were located in the upper third of the esophagus. Forty-six cases of solid intramural benign tumors were observed and were predominantly leiomyomas. The latter may be found at any level but are more frequent near the carina and in the distal third of the esophagus. Seventeen intramural cysts were found and were felt to be of congenital origin and contained derivatives of the primitive foregut. Malignant polypoid and intramural tumors occur which clinically can mimic the benign growths.—*Paul Olfelt, M.D.*

MOTULSKY, ARNO G., and ROHN, ROBERT J. Tietze's syndrome; cause of chest pain and chest wall swelling. *J.A.M.A.*, June 6, 1953, *152*, 504–506.

Tietze's syndrome is described as painful, nonsuppurative swelling of the costal cartilages. Usually the second rib is involved and young adults are prone to have the syndrome. Tenderness is extreme at first and the syndrome is frequently associated with an upper respiratory infection. Roentgen studies are always negative and blood studies, including blood chemistry, are negative. The etiology of the syndrome is obscure.

Two case reports are presented. The patients had pulmonary Hodgkin's disease and in both instances there was either a severe cough or respiratory embarrassment, including symptoms of dyspnea, orthopnea, and choking.

The authors conclude that this syndrome is probably not uncommon, and might be more often recognized if better understood.—*R. E. Kinzer, M.D.*

GERSHON-COHEN, J., INGLEBY, HELEN, and HERMEL, M. B. Roentgenographic diagnosis of calcification in carcinoma of the breast. *J.A.M.A.*, June 20, 1953, *152*, 676–677.

Calcium deposits in malignant breast lesions are punctate with angular margins, thus differentiating them from calcifications in sclerotic arteries, phleboliths, ducts, cysts, fibroadenomas and inflammatory tissues. The calcification may be in the primary lesion or dispersed in the surrounding tissues, thus offering a possibility of diagnosis when the primary tumor is not palpable.—*Fay H. Squire, M.D.*

CHEEK, J. HAROLD. Survey of current opinions concerning carcinoma of the breast occurring during pregnancy. *A.M.A. Arch. Surg.*, May, 1953, *66*, 664–672.

In an attempt to survey current opinions regarding carcinoma of the breast occurring during pregnancy the author submitted a questionnaire to 55 physicians and surgeons who have been especially concerned with mammary cancers and 47 replied. These answers revealed that there was only a 5.3 per cent "five year cure rate" of carcinoma of the breast developing during pregnancy among personally observed cases. All who answered felt that although the prognosis in this group is rather poor an occasional case may be salvaged. There was some difference in opinion regarding the question as to whether pregnancy following a previous radical mastectomy increases the chances of development of carcinoma in the remaining breast but most thought that it does not. The majority felt that termination of pregnancy in patients with cancer of the breast is indicated particularly in the first half of gestation It was generally agreed that subsequent pregnancies should be avoided by women who have had mammary carcinoma.

Any hope for the improvement of the prognosis of carcinoma of the breast occurring in pregnancy lies in the early recognition of the growth when it is still clinically operable.—*Arthur E. Childe, M.D.*

GIRARD, J., GRILLIAT, J.-P., SENOT, R., and FAUCOMPRE, P. Une nouvelle technique de bronchographie: la vaporisation de lipiodol. (A new bronchographic technique: lipiodol vaporization.) *Presse méd.*, June 24, 1953, *61* 914–916.

Lipiodol aerosols, which have been proposed as an answer to some of the problems of conventional bronchography, have proved to be difficult and dangerous to use. The authors attempted to obviate some of these difficulties by preparing a heterogenous mixture of fine lipiodol particles which remain subject to gravity (larger than 6 microns). Vaporization is accomplished by mixing jets of compressed air and lipiodol which are led to the vaporizing chamber by means of a double lumen tube. Following premedication with a barbiturate and atropine the tracheobronchial tree is anesthetized and the double lumen catheter introduced into the trachea so that the vaporizing chamber is at the level of the aortic knob. The bronchial tree may be completely outlined on roentgenograms taken in six positions; in each of these, 1 cc. lipiodol mixture is vaporized over a period of fifteen seconds.

The method is simple, automatic, and allows standardization with ease. It is atraumatic and can be used in patients who are old or in poor condition; no disturbance was noted in 130 tuberculous patients in whom it was employed. Only minimal cooperation is required from the patient. The thin

layer which is obtained outlines all the bronchial contours and demonstrates the slightest anomaly of the mucosa; stagnating lipiodol at the level of dilatation and stenosis contrasts clearly with this fine outline. Most of the lipiodol is expelled in several hours although definite alveolar tatouage persists for four to six weeks or longer.—*Jonas Brachfeld, M.D.*

Baxter, S. G., and Meakins, J. F. Developmental bronchial cysts. *Ann. Int. Med.*, May, 1953, *38*, 967–980.

The authors report 8 cases classified as developmental bronchial cysts with a discussion of the pathogenesis. A simple classification is given.

Chest roentgenograms are reproduced along with photomicrographs of the cases having had surgery. Surgery is the treatment of choice in all cases whenever the local and general conditions permit.—*V. L. Peterson, M.D.*

Scarinci, C., and Zucconi, C. L'étude angiopneumographique des variations de la circulation artérielle dans les poumons bronchectasiques. (Angiopneumographic study of the variations of the arterial circulation in bronchiectatic lungs.) *Presse méd.*, May 20, 1953, *61*, 726–727.

It has been observed that there is diminution of pulmonary circulation in bronchial dilatations. The authors have been able to demonstrate that this diminution is purely functional and that there is no organic change in the blood vessels of the lungs. They attribute, in line with certain other authors, this decrease in the arterial circulation to reflex vasoconstriction caused by bronchiectasis. As proof they submit 6 pulmonary arteriograms showing a definite increase in the pulmonary arterial circulation of a patient (suffering from bronchiectasis) after treatment by bronchial aspiration.—*J. N. Sarian, M.D.*

Studdert, T. C. Farmer's lung. *Brit. M. J.*, June 13, 1953, *1*, 1305–1309.

The author reviews, the literature and presents a small series of cases with acute onset of symptoms following exposure to dust from mouldy hay. The distribution of the reported cases is in the Northwest of England. The disease is rare in hospitals but is seen quite frequently by the family practitioners in smaller market towns.

The clinical picture is that of a distressed, blue, dyspneic patient with crepitations throughout the lungs and roentgenologically increased lung markings with superimposed soft shadows. Spontaneous recovery usually occurs in one to two months with occasionally some residual fibrosis and emphsyema. The main feature of the disease is the intense breathlessness and cyanosis which develop within twelve hours of exposure. The onset is sudden and in the early stages the appearance is that of a case of acute edema of the lungs without evidence of cardiac embarrassment. Hemoptysis and pleurisy did not occur. Skin tests with extracts of the offending dust and stock solutions of aspergillus, penicillium, and mucor were carried out without obtaining specific reactions in any case. The author found mixed fungi in the sputum but feels that this was evidence only that the patient had recently inhaled the dust and does not in any way prove that fungi caused the disease.

Differential diagnosis includes asthma and bronchitis, virus pneumonia, miliary tuberculosis, diffuse granulous pneumonitis of unknown etiology and aspergillosis.

The explosive onset, spontaneous clearing and roentgenologic picture are totally unlike any true fungus disease. The author feels that farmer's lung falls into the group of diseases such as coniosporosis which is pneumonitis involving men working as maple-bark strippers; weavers cough due to handling mildewed cotton; byssinosis, seen in those working in the cotton-mill; and bagassosis.

The theory is put forward that the condition is a nonspecific interstitial lung reaction to some material in the fungus-laden dust, rather than a true fungous infection of the lungs.—*Arthur B. Smith, M.D.*

Silverman, Jacob J., and Talbot, Theodore J. Diffuse interstitial pulmonary fibrosis camouflaged by hypermetabolism and cardiac failure: antemortem diagnosis with biopsy and catheterization studies. *Ann. Int. Med.*, June, 1953, *38*, 1326–1338.

Diffuse interstitial pulmonary fibrosis is a rare condition, the definite diagnosis of which is usually established only after death. The authors present a case correctly diagnosed ante mortem by means of cardiac catheterization and lung biopsy. This was of special interest because of the unusual initial symptoms of hypermetabolism and the fact that it was the first documented instance of this entity in which the lung tissue was studied before and after cortisone therapy.

From a review of the 17 patients described in the literature, in whom diffuse interstitial pulmonary fibrosis has been reported, a characteristic syndrome has been noted. The presenting symptoms in the majority of the cases have been cough, dyspnea, weakness, hemoptysis, cyanosis and fever. On physical examination the findings were usually minimal and not in proportion to the disabling complaints. Pulmonary features were frequently obscured by the effects on the heart and circulation.

Early in the disease, roentgenological evidence was scanty. When heart failure has set in, congestion of the lungs obscured the primary pulmonary con-

dition. Right sided heart failure was a prominent terminal feature.

The authors point out that the mechanism of heart failure stems from several factors, the most important of which is anoxia. Connective tissue proliferation in the alveolar septa interferes with the diffusion capacity of the lungs for oxygen, and an "alveolar capillary block" causes the paradoxic finding of a normal ventilatory mechanism associated with arterial underoxygenation. In addition, the fibrotic process encroaches on the pulmonary vascular bed, reducing its capacity and increasing resistance in the pulmonary circulation. The pressure in the pulmonary artery rises; the right ventricle dilates and hypertrophies and eventually right heart failure develops. Polycythemia may also occur as a result of the anoxic stimulus to the bone marrow and undoubtedly contributes in the late stages to the heart failure and tendency towards thrombosis. An elevated metabolism may also be observed, the basis of which is not well understood.

Cortisone therapy was tried in the patient presented but no real benefit was observed. The connective tissue invasion found in the lungs at postmortem examination was more extensive and less cellular than that noted in the biopsy specimen before the administration of cortisone. However, therapy was undertaken at a time when the destruction and invasive fibrosis was well established. Obviously, if such therapy is to be of value, it should be aggressively applied before the scar tissue encroaches on the capillaries.

There has been a tendency to consider interstitial pulmonary fibrosis as a distinct disease entity. However, no disease etiological agent has ever been established. Hamman and Rich believe it related to viral infection. It is also observed in scleroderma and diffuse lupus erythematosus. The inhalation of certain dusts likewise produces an interstitial pneumonitis which may lead to interstitial fibrosis. Thus in the present state of knowledge it would seem that diffuse interstitial pulmonary fibrosis is not a specific disease entity but probably a syndrome produced by a variety of agents.—*William C. MacCarty, Jr., M.D.*

Roque, Francisco T., Ludwick, Russell W., and Bell, J. Carroll. Pulmonary paragonimiasis: a review with case reports from Korea and the Philippines. *Ann. Int. Med.*, June, 1953, *38*, 1206–1221.

Attention is called to the fact that the diagnosis of pulmonary paragonimiasis should be considered in patients with hemoptysis who have been in the Korean area. The etiologic agent is the oriental lung fluke or *Paragonimus Westermani* which is harbored in cyst-like burrows in the lung parenchyma. The ova are excreted from the body in the sputum or are swallowed and excreted in the stools. These must reach a fresh water pond where a miracidium emerges from each egg and invades a snail. The miracidia develop into cercariae which escape from the snail and invade the second intermediary host, a crustacean of the crab or crayfish family, where they develop into metacercariae.

The disease is contracted in man by ingestion of undercooked crab or crayfish containing the metacercariae. The authors question the necessity of the second intermediary host and present evidence that the disease may be contracted by the ingestion of drinking water containing encysted metacercariae. The larval form, adolescercaria, emerges from the cyst and penetrates the upper jejunum, traverses the peritoneal cavity, penetrates the diaphragm and invades the lung parenchyma where maturation to the adult form takes place. These larvae may become localized at any point en route.

Examination of the lung tissue reveals tunnel-like canals leading into cystic dilatations which are surrounded by an inflammatory reaction and fibrosis. Tubercle-like foci containing caseous material have been described but the authors believe that these are due to coexistent tuberculosis.

The uncomplicated disease causes very few clinical symptoms and may be diagnosed by the triad of hemoptysis, the presence of opercular eggs in the sputum and the positive chest roentgenogram. Contrary to current opinion eosinophilia is not a constant finding.

The roentgenologic appearance is not specific but closely resembles that of pulmonary tuberculosis. Commonly there is a linear patchy infiltration at the periphery or bases of the lung fields. A frequent finding is an area of rarefaction lying within a linear density which correlates with the pathological findings.

The course of the disease is usually quite benign although deaths have been recorded in cases of extensive extrapulmonary involvement or coexistence of severe malnutrition or infectious disease. There is no specific anti-paragonimicidal agent although fuadin and emetine have been used with encouraging results.

Two cases of pulmonary paragonimiasis are presented.—*William C. MacCarty, Jr., M.D.*

Gombert, H. J. Zum klinischen und röntgenologischen Bild einer chronischen Lungen-Toxoplasmose. (Contribution to the clinical and roentgenological picture of chronic pulmonary toxoplasmosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, June, 1953, *78*, 728–731.

Toxoplasma gondii, a sporozoon belonging to the group of coccidioides, was discovered in 1908 in rodents. For an absolutely exact clinical diagnosis the direct culture to the organism is necessary. An important clinical criterion for the diagnosis, how-

ever, is a constantly positive serum color test (Sabin-Feldman).

There are three types of the disease: (1) the infantile type with infection in utero or shortly after birth and almost exclusive involvement of the central nervous system; (2) the juvenile type, resembling an acute encephalitis; and (3) the adult type, resembling Rocky Mountain spotted fever and with a prevalence of pneumonic involvement. The most common is the juvenile type.

The author describes the case of a fifty-seven year old patient with bouts of hemoptysis of four years' duration together with slight temperature increase and leukocytosis (up to 15,000). The roentgen findings of the chest consisted of irregular striations throughout both lungs with a few areas of a more patchy appearance and bilateral slight hilar enlargement. The striations did not follow a specific segmental pattern. Only little roentgen change developed over a period of one year; all tests for tuberculosis remained negative. The Sabin-Feldman test was repeatedly strongly positive. The author believes that this test is sufficiently specific to permit the diagnosis. There is, however, no histological proof.—*E. G. Wissing, M.D.*

Comstock, George W. Mortality of persons with photofluorograms suggestive of cardiovascular disease. *New England J. Med.*, June 18, 1953, *248*, 1045–1050.

During May and June, 1946, 70 mm. photofluorograms were made on 43,429 residents of Muscogee County, Georgia. All of these were over fifteen years of age. Abnormalities of the cardiovascular system were recorded along with the pulmonary findings. Of the persons examined, 739 showed some abnormality of the cardiovascular shadow in the chest.

The author's statistics showed that 0.1 per cent of the white persons between the ages of fifteen and forty-five years had an abnormal cardiovascular contour, whereas 0.6 per cent of the Negroes in the same age group showed abnormalities in their heart shadows. In the age group over forty-five years, the white persons showed abnormalities in the cardiovascular shadow in 5.3 per cent while the Negroes' abnormalities rose to 23.0 per cent. The major difference between the white and Negro races was the greater frequency of hypertension and cardiovascular syphilis in the Negroes.

Of the 739 persons who showed abnormalities in their cardiovascular shadows, 116 were known to have died within three and one-half years after the survey was made. Eighty-one per cent of these died of renocardiovascular disease corresponding to 13 per cent of the entire group of 739 persons. This rate is 31 times the renocardiovascular death rate in the group of white persons who showed no abnormalities in the survey films.

The figures are so striking that the author suggests that the survey films might be of value in segregating part of the group of people with renocardiovascular disease from the general asymptomatic public for possible study or treatment.—*Frank M. Windrow, M.D.*

Weiss, William, Boucot, Katherine R., and Gefter, William I. Localized interlobar effusion in congestive heart failure. *Ann. Int. Med.*, June, 1953, *38*, 1177–1186.

Localized interlobar effusion due to congestive heart failure ("vanishing tumor" of the lung) is relatively rare and not often recognized. Among 2,234 photofluorograms of the chest taken on admission to the Medical Wards of the Philadelphia General Hospital, 5 cases were found; a prevalence of 0.22 per cent. The criteria for suspicion of the lesion were an enlarged heart or abnormal cardiac silhouette and a density in the region of one or more of the interlobar fissures, especially on the right side. Diagnosis was confirmed by demonstrating the disappearance of the lesion on routine therapy for congestive heart failure.

The age of the patients in the 5 reported cases ranged from forty-six to seventy-six years. All but 1 were males. Four had underlying hypertensive or arteriosclerotic heart disease; 1 was rheumatic. The interlobar effusions were all on the right side, usually in the transverse fissure. Postmortem findings supported the theory that "vanishing tumor" occurs in patients with congestive heart failure and an obliterative pleuritis which seals off the interlobar fissure from the rest of the pleural cavity.

Since localized interlobar effusion may simulate tumor, it is important to differentiate it from peripheral bronchogenic carcinoma and pleural fibroma of the interlobar fissure occurring in a patient with congestive heart failure. Lateral chest roentgenograms will facilitate differentiation by determining whether the density is in the plane of a fissure. When the fluid is in the oblique fissure, it tends to be hazier and less well demarcated on the posteroanterior roentgenogram than a collection in the transverse fissure, since it is spread out in a plane not parallel to the direction of the rays. Associated evidence which points to a "vanishing tumor" consists of cardiac enlargement with pulmonary congestion.

Response to cardiac therapy varies with the vigor of treatment. Usually clinical congestive failure disappears prior to the disappearance of the interlobar effusion. The presence of a "vanishing tumor" may be a subclinical sign of congestive heart failure.—*William C. MacCarty, Jr., M.D.*

Dotter, Charles T., Wetchler, Martin S., and Steinberg, Israel. Contrast substances for angiocardiography; study of side effects. *Radiology*, May, 1953, *60*, 691–700.

The three most common radiopaque substances used in angiocardiography today are diodrast (70 per cent), neo-iopax (75 per cent) and urokon sodium

(70 per cent). These chemicals have certain side effects, immediate and delayed.

The immediate reaction to diodrast consists of a sensation of warmth and weakness. Flushing, nausea, cough, thirst, vomiting and urticaria were found in a smaller percentage of patients.

When neo-iopax was used, sensations of warmth and weakness were not as pronounced. Eighty per cent of the patients developed a throbbing headache. The other signs and symptoms quoted above also occurred frequently, especially coughing.

The immediate reaction to urokon was similar to that caused by the other two, but appeared to be milder.

Thrombosis of the injected vein often followed angiocardiography in the authors' series. This occurred in about 48 per cent of the patients receiving one injection and in 76 per cent of those receiving two injections of neo-iopax. Percentage of thrombosis was even higher when diodrast or neo-iopax was employed.

The authors have had no fatalities in their series of 1,733 angiographic examinations (2,669 injections). It is in young children with cyanotic heart disease that the risk of angiocardiography is greatest.

Based on this comparative study, it is the opinion of the authors that urokon sodium is probably the best available contrast substance for angiocardiography.—*McClure Wilson, M.D.*

Calenda, Daniel G., and Uricchio, Joseph F. Superior vena cava syndrome; differentiation between simple obstruction and aorticocaval communication. *A.M.A. Arch. Int. Med.*, June, 1953, *91*, 800–807.

Aortic aneurysm is the cause of approximately 35 per cent of the cases of superior vena cava obstruction. An equal percentage is caused by superior mediastinal tumors, either primary or secondary. A third, but smaller group, is due to chronic inflammatory disease of the upper mediastinum.

The authors present 2 cases caused by aortic aneurysm. One of their cases was associated with a dissecting aneurysm, which is quite rare. They stress the importance of the occurrence of superior caval obstruction associated with severe substernal pain radiating to the abdomen in making an accurate ante mortem diagnosis of obstruction due to a dissecting aneurysm. The other case was that of obstruction due to aneurysm with a fistula between the aorta and superior vena cava.

These cases may be differentiated from others by the presence of: (1) machinery murmur in the third right interspace (62 per cent of cases); (2) systolic thrill (25 per cent); and (3) pulsatile venous pressure. —*Frank M. Windrow, M.D.*

Jacobson, George, Cosby, Richard S., Griffith, George C., and Meyer, Bertrand W. Valvular stenosis as a cause of death in surgically treated coarctation of the aorta. *Am. Heart J.*, June, 1953, *45*, 889–897.

Since surgery now offers the patient with coarctation of the aorta an excellent chance for a complete and permanent cure, the detection of valvular lesions, both congenital and acquired, which are occasionally associated with the coarctation, has become important. Three cases are presented emphasizing the poor prognosis of patients operated upon for coarctation of the aorta who have coexisting aortic, subaortic, or mitral stenosis.

The case reports concern 3 patients with adult type of aortic coarctation of the aorta associated with congenital mitral stenosis (Case 1), subaortic stenosis (Case 2), and calcific bicuspid aortic stenosis (Case 3). All 3 patients died during or shortly after corrective surgery for the coarctation, the complicating valvular disease being held responsible for the operative mortalities.

Coarctation of the aorta is so frequently accompanied by other congenital cardiac anomalies that Maude Abbott in 1928, after collecting and analyzing 200 cases of coarctation of the adult type, stated that "minor anomalies, such as bicuspid aortic valve, anomalous origin of the arteries from the arch, persistent left superior vena cava, defects of the aortic septum, and subaortic stenosis occur relatively so frequent in the adult type as actually to appear to form part of a significant anatomical complex." In 1947 Reifenstein, Levine and Gross reviewed the 104 cases published subsequent to the report of Abbott and made similar observations.

Uncomplicated cases of coarctation of the aorta usually present clinical and roentgenographic features which are easily recognized. On the other hand, an associated valvular lesion may be most difficult to detect. Associated valvular defects should be suspected if any of the following clinical signs are present: (1) congestive heart failure, (2) absence of upper extremity hypertension or lower extremity relative hypotension, (3) harsh systolic or any diastolic murmur in aortic or mitral area, and (4) right axis deviation by electrocardiogram.

Angiocardiography proved of value in Case 1 where specific enlargement of the left atrium was obscured on fluoroscopic and roentgenographic conventional studies by the generalized cardiac enlargement. Excessive and prolonged opacification of the enlarged left atrium was indicative of mitral stenosis, particularly in the presence of murmurs unusual for coarctation and electrocardiographic evidence of right ventricular hypertrophy.

The diagnosis of subaortic stenosis in the presence of coarctation of the aorta is virtually impossble by ordinary roentgenographic methods. Angiocardiography occasionally shows dilatation of the ascending aorta or rarely the stenosis itself.

Visible calcification of the aortic valve is almost pathognomonic of calcific aortic stenosis, and its presence served to establish the diagnosis in Case 3

(a 38 year old male). Noncalcific aortic stenosis offers the same difficulty in differential diagnosis as does subaortic stenosis.—*Harold Fulton, M.D.*

Wyman, Alvin C. Roentgenologic diagnosis of traumatic rupture of the thoracic aorta, *A.M.A. Arch. Surg.*, May, 1953, *66*, 656-663.

Rupture of the thoracic aorta due to a nonpenetrating injury is a major catastrophe which is seldom recognized when the patient is alive and is almost always fatal.

The author feels that with the rapid advance in thoracic surgery some such ruptures should now be amenable to surgical therapy and for this reason he reports 3 fatal cases of the condition. All suffered from severe thoracic injuries, and bedside roentgenograms of the chests in each patient showed mediastinal widening, aortic arch distortion, and indistinctness. Although such findings do not necessarily constitute pathognomonic signs for they may be present in mediastinitis, perforation of the esophagus or mediastinal hemorrhage other than from a lacerated aorta, they should be considered strongly indicative of aortic rupture when found following thoracic cage trauma.

Prompt diagnosis is essential if a fatal termination is to be avoided.—*Arthur E. Childe, M.D.*

Abdomen

Shapiro, Robert. A preliminary report on teridax, a new cholecystographic medium. *Radiology*, May, 1953, *60*, 687–690.

The author reviews the requirements of an ideal cholecystographic medium. The chemical and physical properties of teridax are given and the pharmacology is discussed. Toxicity studies on animals showed the drug to be more toxic than priodax or telepaque although no histological changes occurred in the organs of animals after 5 weeks' continuous treatment on sublethal doses.

Two hundred and twenty-five patients were given a dosage of 3 grams of teridax.

The author concludes that this new cholecystographic medium has a low systemic toxicity and a low level of unpleasant side reactions. It produces a gallbladder density intermediate between priodax and telepaque. The extrahepatic biliary ducts are frequently visualized following the fat meal although the density of the ducts is less than that obtained with iodopanoic acid.—*Everett E. Seedorf, M.D.*

Scott, Wilson R. Preoperative radiographic diagnosis of foreign body within the gallbladder. *Radiology*, May, 1953, *60*, 718–719.

The author reports the preoperative roentgen finding of a metallic foreign body within the gallbladder four months after a patient was injured in combat. Removal of the foreign body resulted in complete relief of previous symptoms characterized by a "sticking" sensation. It is concluded that a foreign body can be present in the gallbladder and produce only mild symptoms with no abnormalities of biliary function.—*Everett E. Seedorf, M.D.*

Sukman, Robert, and Daron, Paul B. Roentgen visualization of the Rokitansky-Aschoff sinuses as an additional sign of chronic gallbladder disease; a case report. *Radiology*, May, 1953, *60*, 714–717.

The authors report the roentgenological visualization of the Rokitansky-Aschoff sinuses of the gallbladder in a patient with chronic cholecystitis. They consider this finding an accurate clinical sign of chronic cholecystitis.

It is pointed out that chronic intracystic pressure leads to herniation of the mucosa through the muscularis, producing the Rokitansky-Aschoff sinuses.—*Everett E. Seedorf, M.D.*

Galano Sánchez, Ranulfo E. Disquinesias biliares. (Biliary dyskinesias.) *Radiología*, Panamá, June, 1953, *3*, 143–152.

There is considerable controversy concerning the subject of biliary dyskinesia. Bockus believes that most of the patients with this syndrome either have had surgery or have a lesion of the biliary tree, accepting only abnormal spasm of the sphincter of Oddi as a possible functional cause. Banuelos is of the opinion that hypertonic and hypotonic dyskinesias account for 5 to 10 per cent of the diseases of the biliary system.

Six patients thought to represent primary and secondary (to other disease) types of hypertonic and hypotonic biliary dyskinesia are presented.

Medical and surgical drainage are effective in treating some patients, while, occasionally, psychotherapy may be indicated.

Cholecystographic features include a large, poorly visualized gallbladder with slow emptying in the hypotonic type. In the hypertonic type, a large gallbladder with exceptionally slow emptying is noted. Although most texts cite the visualization of the cystic and common ducts in the latter type, the author has not seen this in his patients.—*Charles M. Nice, Jr., M.D.*

Fóti, M. Die Röntgenuntersuchung des Magens mit Tetraäthylammoniumbromid (Teab); ein neues pharmakodynamisches Verfahren. (Roentgenologic examination of the stomach with tetraethylammoniumbromide (Teab); a new pharmacodynamic procedure.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, May, 1953, *78*, 566–573.

Teab has a biphasic action on the stomach. After intramuscular injection, the stomach shows an

increase in tonus for ten to twenty minutes. This is followed by a flaccid period lasting two to four hours. Barium is given by mouth immediately after the injection and studies are made in both the spastic and flaccid phases. Unfortunately the reaction to Teab occurred in only 50 per cent of the cases tested. It has been helpful in differentiating functional from organic spastic changes at the cardia, antrum, and duodenal bulb as well as in determining whether a cascade stomach is functional or organic in origin.

Teab has a curare-like effect on the synapses. Intravenous injection has been followed by collapse in several patients.—*Joseph Zausner, M.D.*

O'Leary, Charles M. Diospyrobezoar; a review of fourteen cases with an analysis of forty-six collected cases from the literature. *A.M.A. Arch. Surg.*, June, 1953, *66*, 857–868.

A diospyrobezoar is formed by concretions of the persimmon, a plum-like fruit having a natural distribution in Kansas, Oklahoma, Texas, Iowa, Illinois, Indiana, Ohio, and Pennsylvania.

The diagnosis of the bezoar is a roentgenological one and depends upon the demonstration of free mobility of the intragastric mass.

The initial symptoms depend upon the degree of gastric irritation and are characterized by abdominal pain, tenderness, nausea and vomiting. The acute symptoms subside and are followed by those of a mass and those of a secondary gastric ulcer, which becomes the predominating problem. Of the 14 cases presented, 71 per cent had a gastric ulcer, with complications of bleeding, penetration, or perforation. In view of this, a diospyrobezoar is an indication for surgery, during which careful intragastric exploration is necessary to determine the presence of an ulcer and to exclude multiple bezoars. Three deaths occurred in the author's series, each as a result of a perforated gastric ulcer.—*John F. Weigen, M.D.*

Block, Walter M. Chronic gastric ulcer in childhood; a critical analysis of the literature with report of a case in an eleven-year-old boy. *A.M.A. Am. J. Dis. Child.*, May, 1953, *85*, 566–574.

A case of gastric ulcer in a boy, eleven years of age, is presented with a review of the literature. Only 39 cases of true gastric ulcer were found. There are many other instances of gastric ulcer reported in the literature. In many, the diagnosis was based on clinical observation only and could not be confirmed.

The author's case was confirmed by roentgen examination. He believes that chronic gastric ulcer in childhood can be defined as follows:

1. It is a chronic ulcer of the stomach occurring in children between the ages of one and sixteen years.

2. There must be clinical or pathologic evidence that the ulcer has existed for more than one month.

3. One or more ulcerations may be present.

4. As long as the exact cause of gastric ulcers remains unknown, there must be no concomitant pathologic findings of any other type which may possibly have some bearing on the formation of the ulcer (such as infections, burns, or diseases of the central nervous system).

5. Only those cases in which diagnosis has been made by visualization of the ulcer in a roentgenogram, by surgery or at autopsy are acceptable. Clinical diagnoses alone can hardly be accepted since they will not establish the exact location of the ulcer (gastric or duodenal).—*Ralph S. Bromer, M.D.*

Marshall, Samuel F. The relation of gastric ulcer to carcinoma of the stomach. *Ann. Surg.*, June, 1953, *137*, 891–903.

The substance of this paper consists of a report of 411 consecutive cases of gastric ulcers that came to surgery because malignant disease could not be excluded clinically or because the ulcer recurred or failed to heal. Absolute positive evidence that a gastric ulcer may become malignant or may undergo malignant degeneration is difficult to obtain histologically. Because of this lack of histologic proof, many of the data supporting such conclusions have had to be based upon clinical material. Palmar has shown that there are many pathognomonic signs of malignant disease in an ulcerating gastric lesion but there are no pathognomonic criteria that the ulcer is benign. Such findings as the recent onset of an ulcer, a large size lesion, location on the greater curvature of the prepyloric area, histamine-fast achlorhydria, persistent occult blood in the stools, increase in the size of the lesion under treatment are strong evidence of the possibility of malignant degeneration or a presence of an ulcerated cancer. Wangensteen has pointed out that the mortality following gastric resection for benign gastric ulcer is probably less than 5 per cent, but the mortality from unrecognized gastric cancer treated medically is 100 per cent. The physican assumes a very serious responsibility to the patient when he advises continued medical treatment in the management of chronic recurrent ulcer.

The only safe course to follow in medical treatment of the gastric ulcer is to insist upon complete healing of an ulcer at the completion of six to eight weeks of controlled medical therapy. A malignant ulcer may decrease markedly in size but will not completely disappear. All of these patients with ulcers that fail to heal under good medical management should be operated on early.

Age and sex incidences were essentially the same for benign and malignant gastric ulcers. Of the malignant ulcers, 44.5 per cent were in the prepyloric area and 43 per cent on the lesser curvature of the stomach; 64 per cent of the benign ulcers were also located

on the lesser curvature. The criterion suggested by Kirklin of projection of the ulcer crater beyond the normal boundary of the gastric wall as indicative of a benign ulcer has also occurred in an appreciable number of malignant ulcers. The size of the ulcer is likewise not a dependable criterion to differentiate between malignant and benign ulcer.

The author does not feel that all patients with gastric ulcer should be operated upon, although he does feel that probably 50 per cent or more of chronic gastric ulcers should be resected since 15.8 per cent were found at operation to be malignant. He believes that follow-ups both with the roentgen examination and gastroscopy should be done to show that the ulcer has completely healed and that recurrent ulcers should be treated surgically. In the majority of cases the treatment should be gastic resection—*Arthur B. Smith, M.D.*

Holmes, R. Brian. Intramural extramucosal tumors of the stomach. *J. Canad. A. Radiologists*, June, 1953, *4*, 40–44.

Intramural extramucosal tumors of the stomach are discussed as a single group from a clinical and roentgenological standpoint.

They are said to be the commonest tumor of the stomach. However, a vast majority remain small and asymptomatic.

There are no pathognomonic symptoms or signs. The average age incidence is about fifty-five years. Two-thirds of the patients complain of various forms of gastric distress, such as belching, vague indigestion, nausea and vomiting, or ulcer type of pain and about two-thirds show some evidence of bleeding which may be insidious or manifest itself in melena or hematemesis. In some cases a palpable mass is encountered, but obstruction is not common.

This group of tumors is composed of leiomyomas, lipomas, fibromas, and neurofibromas and their malignant counterparts. The majority are benign throughout their course. Those tumors which are malignant from the beginning probably cannot be distinguished roentgenologically from carcinoma.

Roentgenologically, the lesions appear as sharply defined, smoothly rounded and slightly lobulated translucencies projecting into the lumen of the stomach, usually in the distal third of the stomach. An important finding is that of an abrupt angle formed by the normal stomach wall and the edge of the tumor, as it projects into the lumen. The mucosa of the stomach is normal in pattern and appearance except over the tumor where it is smooth and regular with the rugal markings erased. The folds adjacent to the tumor are soft and pliable. Often the normal mucosal folds of the opposite wall show through the translucency caused by the tumor.

An ulcer may be situated anywhere on the mass. It is sharply defined, narrow and deep, and there is no evidence of accompanying incisura, or spasm of the gastric wall opposite the ulcer.

Aids in diagnosis are compression spot films, and exposures with the patient in various positions. Gianturco has described a technique using barium and mineral oil as the contrast medium.

The radiologist is not always able to separate these tumors from carcinoma. Malignant tumors may have all the characteristics of benign extramucosal tumors, but they usually show more extensive ulceration and a more irregular surface. Infiltration extending beyond the tumor mass erases peristalsis, obliterates the sharp angle between the tumor mass and the adjacent tumor wall and deforms the surrounding rugal pattern. The ulceration is relatively shallow and broader.

Benign gastric polyps, ectopic pancreatic tissue in the gastric wall, and certain extrinsic masses such as the left lobe of the liver, ectopic spleen and pancreatic cysts must be considered in the differential diagnosis.

Three proved cases of intramural extramucosal tumors are presented.—*Claude D. Baker, M.D.*

Levy, Harold, and Zweifler, Ben. The use of banthine bromide in infantile pylorospasm; report of nine cases with x-ray study. *J. Pediat.*, June, 1953, *42*, 673–679.

The authors report 15 cases of infantile pylorospasm confirmed by roentgen study and their results following the administration of banthine bromide. Considerable difficulty is often encountered in differentiating congenital pyloric stenosis from simple pylorospasm. In both, projectile vomiting and visible peristaltic waves may be observed, but in pylorospasm there is little weight loss, no tumor mass is felt and roentgen examination fails to reveal marked interference with stomach emptying.

Nine vomiting infants, ranging in age between three weeks and four months, were subjected to gastrointestinal roentgen study. Serial roentgenograms were made at 30 minutes, 1 hour, 1½, 2, and 4 hours. The patients were given banthine in 5 mg. doses four times a day. Four patients were re-examined within two to eight weeks following the institution of treatment and all revealed a decrease in gastric retention. One infant with cardiospasm was studied. Following the administration of banthine he improved clinically and the roentgenograms revealed less spasm in the distal esophagus.—*James F. Martin, M.D.*

Kirsh, I. E., and Spellberg, M. A. Examination of small intestine with carboxymethylcellulose. *Radiology*, May, 1953, *60*, 701–707.

It is often found that the usual barium-water suspensions are not very satisfactory for roentgen examination of the small intestine. For example, there is

the tendency of this latter mixture to flocculate, especially if mucus is present. Addition of a small amount of sodium carboxymethylcellulose increases the stability of such suspensions, shortens the small-bowel transit time and improves the normal intestinal pattern.

Diagnoses of "deficiency pattern" or "disordered motor function" are not uncommon, and may sometimes be due to erroneous interpretation of nonpathologic segmentation and floccualtion of barium-water suspensions. Addition of a small amount (2.5 per cent) of sodium carboxymethylcellulose is helpful in avoiding this mistake.—*Lynne J. Taylor, M.D.*

Erbes, John, and Stehlin, John S., Jr. Lymphosarcoma of the cecum causing intussusception in a nine-year-old boy. *A.M.A. Am. J. Dis. Child*, May, 1953, *85*, 551–555.

Intussusception is generally considered to be a condition of infancy and early childhood and is usually of the idiopathic type. Intussusception in older children and adults is less common and a causative factor such as a tumor, Meckel's diverticulum, or a foreign body can usually be determined. Few cases of lymphosarcoma, according to the authors, have been recorded. The case they report was considered interesting from the standpoint of diagnosis and treatment.

The patient was a boy of nine years of age. Thirty-six hours after admission to the hospital, a survey roentgenogram of the abdomen showed no evidence of intestinal obstruction, but there was a soft tissue shadow of undetermined origin within the abdomen. A barium enema examination revealed intussusception at about the middle of the transverse colon. This was confirmed at operation. The ileum was easily reduced; however, the cecum presented an unusual appearance. It appeared as if the base of the appendix and the corresponding portion of the cecum had been sucked into the distal portion of the cecum. A mass measuring about 1¼ inches in diameter and firm in consistency was felt through the wall of the cecum in the appendiceal-cecal region. A resection of the ileocecal region, including 3 inches of the terminal ileum, the cecum and 3 inches of the right colon, was done. The histopathological examination revealed a lymphosarcoma. Roentgen therapy was given for an eight day period, the total dose being 1,000 r.

The patient's course after the operation was satisfactory. It was felt that a second operation of exploratory nature was advisable. If a tumor was found, it was hoped that either more definitive surgery could be done or more efficient roentgen therapy could be administered to a smaller field. The abdominal exploration failed to reveal any evidence of recurrence and the lymph nodes appeared negative. The patient's convalescence was uneventful.—*Ralph S. Bromer, M.D.*

Smith, Daugh W., and Sprouse, Daphine. Adenomatous polyps of the colon. *South. M. J.*, May, 1953, *46*, 449–453.

Of all the lesions that confront the surgeon, an adenomatous polyp offers the most optimistic outlook for successful treatment. The emphasis of making a diagnosis is discussed as well as the advisability of repeating negative roentgen examinations where polyposis is suspected clinically.

The authors base their treatment on the pathological tendencies of the various types of polyps found at surgery. Benign polyp with a long pedicle warrants colotomy with excision. The malignant pedunculated polyp will usually show no invasion of the stalk due to absence of muscularis in the stalk. The sessile polyp, if malignant, requires bowel resection but the benign sessile polyp is excised along with its adjacent intestinal wall. Colectomy may be necessary for multiple polyps.—*William A. Klauber, Jr., M.D.*

McCort, James J. Roentgenographic appearance of metastases to the central lymph nodes of the superior mesenteric artery in carcinoma of the right colon. *Radiology*, May, 1953, *60*, 641–646.

Spread from carinoma of the colon to contiguous tissues is accomplished in three major ways: by peritoneal seeding; by venous thrombi reaching the liver through the portal system; and by lymphatic emboli or permeation. Intramural penetration has been found to precede lymphatic spread. Extramural spread is usually accompanied by lymphatic dissemination and by fixation to adjacent structures.

Metastases occur most commonly by way of the lymphatics, which on the right side of the colon parallel the major branches of the superior mesenteric artery. When metastases are present in lymph nodes at the time of surgery, chances of a five year cure are reduced by about 50 per cent.

The presence of lymph node metastases is not significantly correlated with site or size of the primary tumor. Higher grades of malignancy are found to have slightly more tendency to undergo such spread than lower grades

Of the three groups of nodes in the drainage pathway of the right side of the colon, only the central lymph nodes of the superior mesenteric artery can be detected by roentgen examination when enlarged by malignancy, pressing upon or invading the third part of the duodenum. Practical considerations make it difficult or impossible to make routine studies of the duodenum before resection of colon malignancies.

Recurrent carcinoma arising in these central superior mesenteric lymph nodes may invade and deform the third part of the duodenum, in which case it is usually detectable by roentgen examination —*Lynne J. Taylor, M.D.*

Gynecology and Obstetrics

Barter, Robert H., and Parks, John. The advantages of x-ray diagnosis in pregnancy. *South. M. J.*, June, 1953, *46*, 555–562.

The use of roentgenography for diagnosis in pregnancy is becoming more prevalent, and the authors wish to demonstrate specific instances in which roentgen examination has been of great aid to the obstetrician.

Ideally, all primigravid patients should have pelvimetry at term. The importance of mid-pelvic diameters is pointed out and it is claimed that accurate measurement of this plane is possible by roentgen means alone.

Other instances in which roentgen examination is of value are: primary diagnosis of fetal presence; determination of presentation and position of fetus; antepartum diagnosis of multiple pregnancy; differentiation between polyhydramnios and a normal large fetus or twins; estimation of fetal age; antepartum diagnosis of anomalous fetus; and determination of fetal death.

Discussion of fetal hydrops, placentography, abdominal pregnancy, and incidental pelvic findings such as dermoids concludes this very worthwhile article.—*R. E. Kinzer, M.D.*

Erskine, John P., Kelham, Geoffrey, and Wium, Peter P. An assessment of the value of the Chassar Moir graphs in the radiological investigation of cephalo-pelvic disproportion. *J. Obst. & Gynaec. Brit. Emp.*, June, 1953, *60*, 312–318.

These charts apparently have had greater popularity and use in Europe than in this country. The general consensus of American radiologists engaged in pelvimetry seems to tend to concentrate on direct mensuration from the routine upright and inlet projections using only the relatively simple correction-for-magnification tables.

The final conclusion is reached in this discussion of the Chassar-Moir graphs that this method is quite simple, satisfactory and accurate after experience has been gained in its use.—*E. J. McDonald, M.D.*

Roth, Laurence G. Outlet pelvimetry and the symphysis-biparietal and sacral-biparietal diameters. *Surg., Gynec. & Obst.*, June, 1953, *96*, 704–706.

Thoms reported a modification of his original outlet pelvimeter in 1946. Instead of measuring the anterior and posterior sagittal diameters of the outlet as defined by the level of the ischial tuberosities, this modified pelvimeter measures the distances to the lower edge of the symphysis and the sacral tip from the level at which a 9 centimeter transverse bar just passes through the pelvic arch. Since the average biparietal diameter approximates 9 cm., the anterior measurement is called the symphysis-biparietal diameter and the posterior measurement the sacral-biparietal diameter.

The author has studied a series of 236 primiparous patients by clinical and roentgen pelvimetry. In the clinical study the Thoms modified outlet pelvimeter was employed.

He draws the conclusion that the symphysis-biparietal diameter alone has no significance as regards the midpelvis or inlet of a particular individual. His experience suggests that the place for clinical outlet pelvimetry lies in the sort of evaluation outlined by Moloy in which relative terms such as wide, average and narrow are used to describe the outlet and its component parts. The use of a measuring device for absolute numerical values tempts the novice to seek a single denominator that will answer all clinical problems. It is suggested that the Thoms modified outlet pelvimeter may be useful in the hands of individual physicians. When employed in a relative descriptive sense, comparable to the clenched fist, this pelvimeter indicates the available room beneath the pubic arch relative to the posterior segment. Altogether, this study indicates the need for a total pelvimetry which employs all clinical and roentgen techniques as aids in arriving at a clinical judgment.—*Mary Frances Vastine, M.D.*

Davids, Arthur M. X-ray diagnosis of uterine pathology. *Am. J. Obst. & Gynec.*, June, 1953, *65*, 1167–1181.

Hysterography is a simple and safe diagnostic procedure and the gynecologist should not hesitate to use it. It has been a great aid in determining the choice of therapeutic measures.

Indications for hysterography are the following: abnormal uterine bleeding, dysmenorrhea, sterility despite the presence of normal tubal patency and preoperative investigation prior to myomectomy.

The following conditions have been clearly demonstrated by hysterography: (1) endometrial polyps, (2) submucous and intramural fibroids, (3) hyperplastic endometrium, (4) adenomyosis, (5) fundal carcinoma, (6) tuberculous endometritis, (7) congenital anomalies of the cervix and fundus of the uterus, (8) cervical strictures, (9) chronic endocervicitis, and (10) pregnancy and retained secundines.

Uterine polyps are found very frequently and they are usually sharply outlined and do not distort the uterine cavity or produce irregularities of its walls. Although submucous myomas form only a small percentage of uterine myomas, they are important clinically. They impinge upon the endometrium or may actually lie pedunculated within the endometrial cavity. Due to this fact they can cause severe uterine bleeding and dysmenorrhea. Submucous

fibroids, if small and unassociated with other fibroids, are in most instances difficult or impossible to diagnose by palpation. It is in these cases that hysterography is a great diagnostic aid. Submucous fibroids may be single or multiple and vary greatly in size. They may enlarge and distort the uterine cavity in many ways. A small intramural fibroid just beginning to develop a submucous component will produce only slight distortion along one border of the uterine cavity. On the other hand, large intramural fibroids may develop submucous components which produce great distortion and elongation of the endometrial cavity.

The roentgen appearance of the uterine cavity in the presence of hyperplasia of the endometrium depends upon the degree of proliferation. When the hyperplasia is moderate or marked and there is no polyp formation, the uterine cavity is either normal in size or slightly enlarged. The borders of the roentgen image are hazy due to the prominent folds of the endometrium while the central area shows a uniformly dense shadow without filling defects.

Untoward reactions to the investigation of the uterine cavity with water-soluble media are very infrequent. It is only when large amounts of the opaque substance are employed for outlining the fallopian tubes that one encounters pain due to spill into the peritoneal cavity or due to distention of the uterus and tubes under higher pressure. The use of water-soluble media obviates the disadvantages of lipiodol and other oil media. Embolization and residual granulomas in the fallopian tubes and peritoneal cavity do not occur since there is rapid and complete absorption of the water-soluble media. Phenomena from an allergy to the opaque substance employed have occurred in very rare instances and have been easily controlled with antihistaminics and sedation. Pelvic inflammatory reactions are rare.—*E. J. McDonald, M.D.*

Olnick, Herbert M., and Hatcher, Milford B. Meconium peritonitis. *J.A.M.A.*, June 13, 1953, *152*, 582–584.

Meconium is extremely irritating to the peritonea surface and, although sterile, gives rise to a vigorous adhesive process followed in time by calcification. Perforation of the fetal intestinal wall allowing leakage of its contents can apparently result from a number of events leading first to obstruction or localized weakness and then rutpure. In large intestinal obstruction, perforation may be multiple while in small intestinal obstruction it often occurs approximately 10 cm. proximal to the site of obstruction.

Roentgen examination is of definite aid in demonstrating gas-distended loops of intestine behind an obstruction, free abdominal air shortly after perforation has occurred, or the streaky calcification in the parietal peritoneum at a later date.

The authors report 2 cases of calcified meconium peritonitis. The second of these is quite unusual in that it represents an apparent spontaneous recovery during fetal life, and exhibits the unusual findings of peritesticular calcification as well as peritoneal calcification.—*James A. Martin, M.D.*

Anderson, A. F., Grant, Marie P. S., McBryde, Rhona M., and Cockburn, M. Kathleen. The place of cervical smears in the diagnosis of early cervical cancer. *J. Obst. & Cynaec. Brit. Emp.*, June, 1953, *60*, 345–352.

This series of cases began as an investigation of the method, of its practical use in clinical gynecology, and of the question whether the time spent on taking, staining and interpreting the smears was worth while as an aid to the diagnosis of early carcinoma of the uterus.

The cervical smear study is not in itself a complete diagnostic procedure, and radical treatment should never be undertaken on the basis of a positive report unsupported by positive biopsy, but it indicates those patients in whom biopsy should be performed in the absence of clinical suspicion. If the cervix appears to be healthy and there is no obvious target area from which the biopsy should be taken, the authors advise ring biopsy of the entire junctional epithelium and endocervical curettage, as otherwise early cancer cannot be excluded in cases with suspect smears.

In this group of 3,000 patients, 71 cases of uterine malignancy were encountered, 50 cervical and 21 endometrial. All obvious cervical cancers, and known cancers under treatment, were excluded; these numbered 139. The positive correct reports came only from unsuspected cases, or cases in which the clinician suspected the possibility of cancer but required a biopsy to prove it. Had the clinically known cases been included the percentage of correct results would obviously have been very much greater. —*E. J. McDonald. M.D.*

Genitourinary System

Rothfeld, Samuel H., Hamm, Frank C., and Harlin, Harrison C. Perirenal air insufflation by paracoccygeal method. *J. Urol.*, May, 1953, *69*, 721–725.

This method is an improvement over the lumbar perirenal insufflation because it permits bilateral visualization with less danger of air embolus, pneumothorax or pneumomediastinum. When combined with translumbar aortography it has been found to be of inestimable value in the diagnosis of renal tumors, cysts and other pathological entities.

The procedure is simple. Under local anesthesia and using aseptic technique, one finger is placed in the rectum as a guide. The 18 gauge spinal needle is

then inserted through the skin 1½ inches lateral to the midline of the sacrum and at the level of the finger tip in the rectum. The needle is directed anteriorly and toward the midline, being careful not to pass it into the rectum. One thousand cubic centimeters of air is injected and roentgen studies are made immediately and at intervals as indicated.

The authors have injected over 200 patients using this method without serious complaints or complications.—*George W. Chamberlin, M.D.*

Porporis, Arthur A., Zink, Oscar C., Wilson Hugh M., Barry, Carey N., Royce, Robert, and Rose, D. K. Routine clinical experiences using urokon sodium 70% in intravenous urography. *Radiology*, May, 1953, *60*, 675–686.

This article reviews experiences in 189 cases with urokon sodium 70 per cent, a new contrast medium for excretory urography. Dosage for these examinations was approximately 50 cc., to which was added 100 microcuries of radioactive iodine. Proper timing for the initial roentgen exposure was indicated by means of a scintillation counter placed over the femoral artery. The authors believe that a precisely timed abdominal aortogram followed by a single roentgenogram embodying a nephrogram, hepatogram, and lienogram is adequate for most urologic problems in which information regarding renal arterial supply and renal parenchyma are needed to supplement the pyelographic findings.

The authors also report on 2,500 cases in which excretory urography was carried out, using 15 cc. of urokon sodium 70 per cent per square meter of surface area. Pyelograms obtained were graded with reference to the quality of well-filled retrograde pyelograms. Of 1,160 cases, 381 urograms were equal in quality and 519 were slightly inferior to retrograde studies; 232 were of fair quality and 28 were unsatisfactory.

The authors believe that it may be of importance to control the volume of urinary excretion during excretory urography. They have also found that abdominal compression is, in their hands, of use in insuring distention of the renal pelves and upper ureters.

Attention is called to reactions (10.5 per cent) which have been reported following the use of urokon sodium 70 per cent, and a case of a severe shock-like reaction is presented.

Several case reports illustrating some of the roentgen findings obtained from intravenous injections of urokon sodium 70 per cent for arterionephrography, pyelography and cholecystography are included.—*Arthur R. Watson, M.D.*

Barry, Carey N., and Rose, Dalton K. Urokon sodium 70 per cent in excretory urography. *J. Urol.*, June, 1953, *69*, 849–855.

Indications are that a more concentrated medium will increase the percentage of surgically diagnostic intravenous urograms since most poor results are due to insufficient concentration of contrast medium and continued peristalsis of the renal drainage system. The authors reviewed comparison of various concentrations of urokon, neo-iopax, and diodrast. In this article they summarize the use of 70 per cent urokon in over 1,000 patients.

The technique consisted of prior catharsis. Then a routine plain roentgenogram of the abdomen was taken followed by injection of 50 cc. of 70 per cent urokon. Injection time ranged from fifteen to twenty seconds. Urograms were made at five, ten, and fifteen minutes in adults.

The increased density of the urograms rendered films of more diagnostic value. Sixty-two per cent were judged surgically diagnostic with an increased 10 per cent value when pressure blocks were used.

The urokon was excreted rapidly and in unchanged form. Most was recovered in the urine in the first six hours and over 90 per cent in twenty-four hours.

Almost 90 per cent of patients had no reaction to the injection of urokon. In the remaining cases nausea, vomiting, a bitter taste and minimal flush were the most common reactions. It appears that the psychic state is a big factor in the reactions. The observation in 50 per cent of patients of a transient shower of tubular epithelial cells in the urine following excretion of urokon bears further examination.

The authors believe that following more investigation the use of 70 per cent urokon will increase the diagnostic accuracy in surgical uropathy.—*George W. Chamberlin, M.D.*

Mortensen, JD, Emmett, John L., and Baggenstoss, Archie H. Clinical aspects of nephrocalcinosis. *Proc. Staff Meet., Mayo Clin.*, June 3, 1953, *28*, 305–312.

The authors were able to accumulate only 91 cases of roentgenographically demonstrable nephrocalcinosis from the literature and the Mayo Clinic. Urinary lithiasis was found to be 200 times more common. One case of nephrocalcinosis was found per 3,000 routine necropsies.

There are no pathognomonic subjective symptoms, physical findings, or laboratory studies. Diagnosis depends on the roentgenographic demonstration of diffusely distributed calcium deposits in the renal parenchyma. Identification of the primary disorder requires the following laboratory determinations of the chemical constituents of the blood: Carbon dioxide combining power, calcium, phosphorus, chlorides, urea.

Of the cases, 75.9 per cent were due to primary hyperparathyroidism, hyperchloremic acidosis, or chronic pyelonephritis. Single cases were due to

chronic glomerulonephritis, recurrent idiopathic renal lithiasis and idiopathic hypercalcinuria. In 16.5 per cent the definitive causative disorder could not be identified.

Contrary to common belief, no cases of roentgenographically demonstrable nephrocalcinosis were caused by vitamin D intoxication, multiple myeloma, metastases, intestinal obstruction, ingestion of alkalies, or mercuric poisoning.

Prognosis is affected by treatment of the primary disorder and is not necessarily poor. Patients with extensive nephrocalcinosis have been followed for over ten years with normal renal function.—*Fay H. Squire, M.D.*

Bettge, S., and Feigel, G. Ein Beitrag zur Pathogenese und Therapie der renalen Osteopathie (renale Rachitis). (Contribution to the pathogenesis and treatment of renal osteopathy [renal rickets].) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, June, 1953, *78*, 689–697.

The syndrome of "renal rickets" or, as the authors prefer to call it, "renal osteopathy" consists of (1) renal insufficiency (chronic nephritis or nephrosclerosis); (2) osseous changes, frequently resembling those of rickets; and (3) marked increase of serum phosphatase with normal or slightly decreased serum calcium.

The authors describe the case of a fifteen year old boy, fulfilling the above requirements and then give a pathological anatomical discussion of the syndrome. The renal insufficiency develops first and plays the leading part in the evolution of the disease. This renal insufficiency causes hyperfunction of the parathyroids due to a drop in the calcium level and an increase in the serum phosphorus. The hypocalcemia causes increased function of the parathyroids and increase of osteoclasis. The parathyroid glands are usually enlarged. This secondary hyperparathyroidsim is the real cause of the bone changes which are part of the syndrome. The decrease of the serum calcium level is thus a requirement for development of a secondary hyperparathyroidism. In ordinary rickets, the calcium deficit is due to lack of vitamin D, in "renal rickets" to kidney disease. This latter should, therefore, be called "renal osteopathy."

These pathogenic considerations suggest a therapy which (1) compensates for the intestinal loss of calcium; (2) reduces the overactivity of the parathyroid by increased calcium ions; (3) repairs the bone defects by increased calcium administration.

Accordingly, the patient was treated with calcium carbonate (with citric acid) and with Vigantol (vitamin D). After a few weeks, he was much improved, was able to walk better and the bone changes, previously seen on the roentgenograms, had almost completely disappeared. The serum phosphorus decreased from 16.5 mg. to 5.9 mg. per cent and the serum phosphatase from 67.8 BE to 17, but later started to increase again. The original renal insufficiency showed no change. After cessation of therapy, the bone changes recurred. A second course of therapy again caused improvement.

The authors see in the result of the treatment a proof for the correctness of their idea concerning the pathogenesis of this syndrome.—*E. G. Wissing, M.D.*

Haubrich, R., and Thurn, P. Nebennierentumoren im Pneumoretroperitoneum. (Adrenal tumors demonstrated by pneumoretroperitoneum.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, June, 1953, *78*, 719–723.

Presacral air insufflation permits roentgen visualization of organs which are otherwise difficult to demonstrate. Sometimes additional procedures, such as pyelography or laminagraphy, are of special value to eliminate errors. Hyperplasia of the adrenals causes enlargement but the triangular shape is maintained, while tumors (pheochromocytomas) cause irregular enlargement with loss of the triangular shape.

The authors describe 4 cases, 2 operatively proved cases of hyperplasia, 1 case of pheochromocytoma and 1 case where an enlarged spleen was confused with an enlarged adrenal, with the presence of symptoms suggestive of adrenal pathology.—*E. G. Wissing, M.D.*

Levy, Abraham H., and Schwinger, Harold N. Gas-containing perinephric abscess. *Radiology*, May, 1953, *60*, 720–723.

A case of a gas containing perinephric abscess, apparently the third of this type described in the literature, is presented.

The patient, a sixty-five year old white woman, was brought to the hospital in a confused state of mind and was unable to give an adequate history. For three days, she had complained of pain in the right abdomen. Physical examination was inconclusive. The initial roentgenogram of her abdomen showed a collection of gas in the right upper quadrant. Considered in the differential diagnosis were gas containing perinephric abscess, emphysematous cholecystitis, and liver abscess. Further studies revealed the gas to be posterior and perirenal in location. It was noted that the gas had infiltrated the retroperitoneal space, indicating that a perinephric abscess had perforated its capsule. *E. coli* was the causative organism.

Roentgenographic findings to be sought in perinephric abscess are: obliteration of the lateral border of the psoas muscle; obliteration of the kidney shadow; curvature of the spine, with the convexity away

from the abscess; displacement of the colon; displacement, fixation and limitation of mobility of the diaphragm; renal fixation; anterior and outward displacement of the kidney; rotation of the upper calyx as noted in the pyelogram. Any one or a combination of these findings may or may not be present in an individual case.

A possible triad of diabetes, low urinary tract obstruction, and colon bacillus infection may be a common factor in gas containing perinephric abscess.—*Arthur R. Watson, M.D.*

Lattimer, John K. A roentgenographic classification of tuberculous lesions of the kidney. *Am. Rev. Tuberc.*, May, 1953, *67*, 604–612.

The author recognizes the inadequacy of existing classifications for renal tuberculosis and offers a classification by a combination of clinical, laboratory and roentgen criteria. Insofar as possible, all confusing factors such as strictures of the ureter, etc., are relieved before the classification is made.

The definite proof of renal tuberculosis is a positive culture for *M. tuberculosis* from the urine, a positive guinea pig test, or positive histologic evidence after surgery. Positive smears for acid-fast bacilli were not accepted for research purposes. As soon as the diagnosis was established in this manner, the extent of the kidney lesion was estimated by roentgenographic examination.

The roentgen classification includes five groups. *Group 0* shows no roentgen abnormalities. *Group 1* shows very slight roentgen abnormality, calyceal distortion, irregularities of the pelvis or upper ureter. *Group 2* shows only one calyx involved with definite roentgen changes of tuberculosis. *Group 3* shows two calyces involved, and *Group 4* shows three or more calyces involved.

The author discusses the following points: (1) *Calcification.* The presence of calcification did not alter the assignment of the lesion to its proper group, but did eliminate it from assignment to *Group 0* or *1*. (2) *Hydronephrotic kidneys.* These were difficult to assign and it was necessary to first correct the condition of "back pressure" before a true estimate of the renal lesion could be determined. False diagnoses were sometimes caused by reflux. (3) "*Excluded*" *lesions.* In these the tuberculous process was excluded from the remainder of the kidney by scarring and fibrosis, a fact which also applied to the "putty" kidney. The author states that the difficulty in this type arose very infrequently, for the diagnosis could not be established since the lesion was isolated and was not acceptable for research purposes. The lesions were assigned to *Group 3* or *Group 4*. (4) *Significance of symptoms.* These were not reliable since 50 per cent of the patients had no symptoms, either in the form of bladder dysfunction or lumbar pain. (5) *Criteria of arrest.* A period of three months was allowed in order to eliminate any question of temporary "conversions" due to residual chemotherapeutic agents.

The author elaborates somewhat on the classification and considers that *Group 0* has a favorable prognosis. *Groups 1* and *2*, likewise, have a good chance of being arrested by chemotherapy. *Groups 3* and *4* have massive kidney involvement with a large amount of necrotic tissue and, therefore, offer a much poorer prognosis for arrest through chemotherapy.

The classification of kidney lesions as to size is independent of the duration of the disease. It is the author's impression that tuberculous lesions large enough to be definitely identified by roentgen examination contain so much necrotic tissue that conversion by chemotherapy alone is questionable. He states that early diagnosis by demonstration of persistent pus in the urine and cultures is of extreme importance. He also calls attention to the harboring of tubercle bacilli in the prostate.—*P. B. Parsons, M.D.*

Skeletal System

Doub, Howard P., and Henny, Fred A. Radiological study of the temporomandibular joints. *Radiology*, May, 1953, *60*, 666–674.

A succinct comprehensive description of the temporomandibular joints is given. These joints are true articulations, each being divided into two separate cavities by the fibrocartilaginous meniscus which acts as a cushion. The primary movements of the joint are: a hinge motion, a gliding forward motion (protrusion and retraction), and a lateral rotary motion with one condyle rotating on its vertical axis.

Anatomic variations consist of (1) the normal joint, (2) the flattened gliding joint with a large joint space, and (3) the marked convex joint, showing a deep mandibular fossa, reduced disc space, and often associated with an overbite. The techniques for obtaining roentgenograms in both open and closed positions are given in detail.

Malocculsions are felt to be a chief cause of temporomandibular joint disturbances. Thus, unusual stress causes pain, limited motion, a snapping or noisy joint (in which the meniscus is always at fault), and later, anatomic joint derangement. The temporomandibular joints are also subject to the same arthritides as peripheral joints.

In acute degenerative disease of the temporomandibular joints, one sees (1) clouding of the joint with blurring of the articular surface, (2) slight narrowing of the joint space in the closed position, with the condyle displaced posteriorly and superiorly, indicating articular cartilage absorption, and (3) alteration of excursion of the condyle.

When the disc has largely disappeared and a chronic degeneration has developed, there is (1) considerable narrowing of the joint space, (2) restricted con-

dylar movement, (3) flattened, irregular joint surfaces and possibly hypertrophic changes, and (4) sometimes, loose bodies and marginal sclerosis.

Treatment is usually by rest and immobilization, correction of malocclusion, and symptomatic medication. Roentgen therapy and intracapsular injection of hydrocortisone aid in inflammatory relief. In severe and advanced cases, meniscectomy is the treatment of choice.—*William A. Goodrich, Jr., M.D.*

Smillie, I. S. Intermetacarpal fusion. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 256–257.

Fusion of the metacarpal of the opposed thumb to that of the index finger may be applied to the hand grossly paralyzed by anterior poliomyelitis when tendon transplants are not available or have failed, and to certain cases of spastic paralysis and trauma. The author states the disadvantages of the current operation are the difficulty of slotting a bone graft into the atrophic metacarpals of a paralytic hand and thereafter the necessity of maintaining accurate apposition by a plaster until fusion is sound. The procedure he describes requires no more attention to detail than is necessary in the standard method but has the additional desirable feature that at the termination of operation the metacarpals are locked in the required position, avoiding the need for external means of immobilization.

A piece of fibula is removed in the operation and is inserted between the two metacarpals by a fine pin or Kirschner wire. Roentgenograms, taken after operation, are reproduced showing the pin in position holding the graft in place.

The theoretical objection is mentioned, namely, the possibility of infection of the pin track. The author's limited experience suggests that with reasonable care the advantages outweigh greatly the risk. In 4 cases in which he used the method, the pin was removed after the arbitrary interval of eight weeks and all points of entrance and exit were dry. The grafts were revascularized and united in twelve to sixteen weeks.—*Ralph S. Bromer, M.D.*

Bradley, K. C., and Sunderland, S. The range of movement at the wrist joint. *Anat. Rec.*, June, 1953, *116*, 139–145.

The authors report their findings on a patient in whom the intercarpal and carpal-metacarpal articulations had been destroyed by bony fusion. The nature and distribution of this ankylosis were such as to permit a study of the range of movement possible at the sole remaining functional joint, the radiocarpal.

Measurements of the range of motion were made with posteroanterior roentgenograms of both hands at rest and in extreme radial and ulnar deviation, and lateral roentgenograms in extreme flexion and extension. From tracings of the bony outlines made from the films the authors concluded that movements of flexion and extension occur normally at both radiocarpal and midcarpal joints. In each case the amount of movement occurring at the latter joint exceeds that occurring at the former. Radial deviation was found to be produced entirely at the midcarpal joint whereas ulnar deviation was unaffected by fusion of the midcarpal joint. Following the loss of movement at some joints, they felt the range of movement at other joints might be increased in order to compensate for the loss.—*Denis V. Campbell, M.D.*

Stratford, Bryan. The Trumble graft; a review of thirty-six cases. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 247–253.

In 1932, Trumble described a method of fixation of the hip joint by means of an extra-articular bone graft. In this paper, 36 cases are reported; the size and position of the graft, end results and complications are discussed.

The conclusion is reached that a short, wide graft, placed horizontally between the femur and the ischium, gives the best results, and that a long obliquely placed graft is less satisfactory and more liable to fracture.

Roentgenograms and photographs of necropsy specimens are reproduced showing results of the operation.—*Ralph S. Bromer, M.D.*

Wheeldon, F. T. Uncommon complication of slipping of the upper femoral epiphysis. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 196–198.

Although for some time it has been recognized that imperfect results after the reduction of a slipped upper femoral epiphysis may arise from the formation of new bone on the under surface of the neck of the femur, it was thought worth while by the author to record a clear example of the condition where such new bone was removed at operation. It is believed to be the only published record of direct operative attack upon this complication of adolescent coxa vara.

A schoolboy aged fifteen, was operated upon for a slipped upper femoral epiphysis. Approximately two years and nine months after operation, there was persistent abduction deformity, accompanied by sharp attacks of lumbago which so added to his discomfort that a futher operation was necessary. The capsule of the hip was incised longitudinally to expose the bony boss which had been brought into the bottom of the wound by abduction and lateral rotation of the femur. It was situated at the lowest part of the neck, immediately distal to the margin of the articular cartilage and was smooth and covered with periosteum. It had the appearance of a simple exostosis. Three years after this removal of the bony boss, the patient was accepted for military service in the highest category.

It was suggested that the new bone formation on the inferior aspect of the femoral neck in this case was due to organization of callus formed in the angle between the head and neck of the femur in the stage of chronic slipping, the mass being left behind on the prominence of the neck when the head was reduced upwards. However, the bony boss in the author's case was perhaps increased by the over-correction upwards of the displacement, but that alone does not seem to have been sufficient for the exostosis that developed or for the striking deformity that it produced.—*Ralph S. Bromer, M.D.*

Morrison, A. B. The os paracuneiforme; some observations on an example removed at operation. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 254–255.

The author states that rare accessory or inconstant bones of the foot are usually regarded as collectors' pieces, often of little more than academic interest. But from time to time such bones cause symptoms requiring surgical treatment. His case was that of a young man, aged twenty-eight, with the complaint of pain of three months' duration over a small bony swelling on the medial side of his right foot. Roentgen examination showed a well-formed os paracuneiforme articulating with the medial aspect of the medial cuneiform. The bone was partly accommodated in a hollow occupying the anterior two-thirds of the cuneiform, but it projected beyond the general level of the medial border of the foot. No other abnormality was noted. A roentgenogram of the left foot showed no abnormality.

The author regards the case as of interest from two aspects: (1) it is unusual for an accessory bone to cause symptoms requiring surgical intervention; (2) the relationship of the anterior tibialis tendon to the bone, as shown at operation, stimulates speculation as to whether the os paracuneiforme should be regarded as a true accessory bone, as a sesamoid, or perhaps as an example of an united traction epiphysis. The distinction between accessory bones, sesamoids and traction epiphyses is not clear cut. He thinks that since it was not of traumatic or pathologic origin, the presence of the bone must be explained in terms of an anomaly of ossification.—*Ralph S. Bromer, M.D.*

Marsh, Kenneth. Stress fractures of ribs in successive pregnancies. *J.A.M.A.*, May 2, 1953, *152*, 26–27.

The author reports a case in which two rib fractures occurred in the last weeks of one pregnancy and another fracture toward the end of the second pregnancy. All of the fractures occurred on the left side and involved the lower ribs.

He reviews the literature on the subject and comments upon the possible relationship of the mechanism to so-called "stress fractures" of the first and second ribs which are observed in men subjected to unaccustomed exertion. It is believed that the fractures occur as a result of postural changes and altered muscle stresses in pregnant women. It may be that some direct pressure is exerted by the high uterine fundus.—*C. L. Hinkel, M.D.*

Urist, Marshall R. Obstetric fracture-dislocation of the pelvis; report of a case with injury to lumbosacral trunk and first sacral nerve root. *J.A.M.A.*, May 9, 1953, *152*, 127–129.

The author reports the case of a thirty-seven year old woman who experienced a fracture of the sacrum with disruption of the left sacroiliac synchondrosis and symphysis pubis during the course of labor.

About one and one-half hours after the onset of labor, she experienced a sudden, sharp pain in the left sacroiliac region and heard a "cracking" sound. The pain was fleeting but recurred twenty-four hours after delivery when she attempted to sit up or get out of bed. There was a "lump" on the left side of the low back, numbness, tingling, coldness, and lack of sensation in the left leg, and weakness of the left ankle. These symptoms and a waddling gait continued for six weeks, at which time she was investigated by roentgen studies which showed a displaced fracture-dislocation of the left sacroiliac joint and complete separation of the symphysis pubis.

She had developed a rotoscoliosis at the age of eleven and during the preceding five years had had repeated attacks of low back pain radiating into the left leg. A waddling gait had developed in the middle and last trimesters of her pregnancy.

The symptoms had been alleviated somewhat by the use of a lumbosacral corset. She was treated by Russell traction and manipulation in an attempt to reduce the fracture-dislocation. Following three weeks of conservative management, the pain had largely disappeared, although roentgen examination made one year following the original injury showed no change in the configuration of the pelvis.

The article includes reproductions of a roentgenogram of the pelvis made at seven months which shows no deformity, of roentgenograms showing the fracture-dislocation and of a myelogram showing asymmetry of the first sacral roots. There is a detailed description of the orthopedic examination and a comment by the author on the role of the sacroiliac joints and symphysis pubis as shock absorbers during the course of labor. There is also a brief discussion about "relaxin" and its role in causing elasticity and expansibility of the structures about these joints during the course of labor.

The author believes that this is the sole case reported showing injury to the sacral nerves and emphasizes the good results with conservative management.—*P. B. Parsons, M.D.*

Evans, John. Leontiasis ossea; a critical review, with reports of four original cases. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 229–243.

This paper consists of a review of 149 cases of leontiasis ossea reported in the literature. The author adds 4 more. The clinical, roentgenographic and pathologic features of the condition are discussed.

A new classification of leontiasis ossea is suggested, by which the condition is divided into true leontiasis and false (or symptomatic leontiasis). True leontiasis is a clinical symdrome caused by two distinct types of disease, the pathology of which, however, is related. The roentgen features of Type 1 may take three forms. There may be localized sclerosis beginning in the maxilla and spreading to the frontal bone and sometimes to the cranium and lower jaw. The sclerosis may not be complete in the second form but is etched out by small translucent patches and areas of normal bone. In the third form, sclerosis of the facial bones is associated with a generalized sclerosis affecting other parts of the skeleton as in Albers-Schönberg's disease. The sclerosis in true leontiasis may be periosteal or endosteal. The antra are dull and often are obliterated by the fibro-osseous mass. The sclerosis may affect the cervical vertebrae, but the inner table of the skull is not affected.

In the second type of true leontiasis ossea the author made the following observations. The facial bones show typical trabeculated and cystic appearance of a localized osteitis fibrosa. The cortex may be seen as a paper-thin shell. The base of the skull shows sclerosis, a characteristic finding. The calvarium is thickened and may present an appearance similar to that of Paget's disease except that the inner table is intact. Osteoporosis circumscripta cranii occurs frequently.

Of the 153 cases that were studied, the author classified 97 as examples of true leontiasis ossea. Of these, 45 were of Type 1 and 52 were of Type 2. Forty cases were classified as false (or symptomatic) leontiasis and 16 did not fall into either category. The false cases were composed of cases of syphilitic osteoperiostitis, Paget's disease, pituitary lesions, craniostenosis, congenital gigantism and tumors of the maxilla.

The unclassified cases consisted of localized osteitis fibrosa, chronic hyperplasia of the maxilla, dyschondroplasia, Albers-Schönberg's disease, neurofibromatosis, osteogenesis imperfecta with platybasia, Allbright's syndrome not showing leontiasis, Paget's disease not showing leontiasis, meningioma and 2 cases were undiagnosed.

The treatment is mostly symptomatic. The most important step is to check and relieve eye symptoms by decompression of the optic nerve. Operations such as lateral orbitotomy, transfrontal orbitotomy or subzygomatic decompression may be necessary according to the position of the growth. Nasal stenosis may require treatment by resection of the septum. Associated infection in the form of antral empyema, ethmoiditis, dental infection, dacreocystitis or gingivitis may need appropriate treatment. Neuralgia of the fifth nerve may require operation. In the Type 2 cases occasionally the normal facial contour may be restored by plastic operations.

Roentgen therapy may be used alone or in conjunction with surgery, according to the author, who states that it has proved to have a beneficial effect in all cases. The dosage recommended is 2,000 to 3,000 roentgens.—*Ralph S. Bromer, M.D.*

Owen, R. Bilateral glenoid hypoplasia; report of five cases. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 262–267.

Five cases of bilateral gelnoid hypoplasia are reported, all of which had in common a bilateral defect of the glenoid articular surface of the scapula accompanied by flattening of the humeral head. In some of these, there were associated abnormalities in the axial skeleton; in 2 cases only was there marked disability. The explanation suggested by the author as the cause of the condition is a failure of development of the inferior apophysis of the scapula.

In general, the roentgen examination shows a defect of the glenoid fossa, predominantly the inferior half of the articular surface. The humeral heads have often an oval shape. In 1 of the cases, there was at the lateral ends of both clavicles a curious hooked appearance with a bony knob protruding from the anterior inferior aspects at the site of insertion of the conoid and trapezoid ligaments. The carocoid processes were large and prominent.

This condition must be differentiated from similar acquired deformities of the shoulder. Thus, in the case described by Scaglietti bilateral humerus varus with epiphyseal hypoplasia was ascribed to birth injury to the upper numeral epiphysis. Other recognized causes of humerus varus produce transient softening of the humeral head in early life, such as rickets and Barlow's disease. Unilateral deformity may arise from injury to the epiphysis in early life, in the formative years between five and twelve, with consequent osteochondritis. Erb's palsy, producing secondary disuse atrophy of bone from muscular weakness, and the muscular dystrophies are sometimes associated with hypoplastic humeral heads and glenoid cavities. Fairbanks' multiple epiphyseal displasia can give a similar picture, but changes are present in the other joints such as the hips.—*Ralph S. Bromer, M.D.*

Whiston, T. B. Neurofibroma eroding the carpus; report of a case. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 260–261.

The author states that the incidence of skeletal changes in neurofibromatosis (von Recklinghausen's disease) is only 7 per cent. These include increase of

length, erosion of bone, cyst-like areas and joint changes. Increase of bone length is associated with hyperemia as in elephantiasis neuromatosa. Erosion of bone may result from direct pressure of contiguous soft tissue tumors. Periosteal nerve involvement may produce erosive defects of the cortex, deformity, irregular sclerosis and subperiosteal cysts. The case reported in this paper belonged to the last category.

Roentgenograms of the case showed cystic changes in the bones of the right carpus, at the ulnar side of the wrist and also involving the styloid process of the ulna and base of the fifth metacarpal.

The author quotes Lichtenstein and Jaffe who considered a fundamental genetic defect as the cause of the condition.—*Ralph S. Bromer, M.D.*

Briggs, J. N., Emery, J. L., and Illingworth, R. S. Congenital stippled epiphyses. *Arch. Dis. Childhood*, June, 1953, *28*, 209–212.

The authors present a case which they believe fits the syndrome which Caffey calls "congenital stippled epiphyses," consisting of achondroplasia, roentgen evidence of discrete centers of calcification in the cartilaginous epiphyses, together with cataracts and mental deficiency.

This patient had these findings and, in addition, a congenital cardiac deformity, hydronephrosis and hydroureter. She had the appearance of a cretin along with high total serum lipids (947 mg. per cent), but showed no response to thyroid extract therapy. Roentgenograms revealed stippling of the epiphyses of many bones.

The patient did not develop normally, gained little if any weight and died at the age of nine months of an acute respiratory infection. Postmortem examination showed enlargement of the ends of the long bone and limitation of motion by large cartilaginous masses. Histologically there was increased vascularity with areas of degeneration and calcification in the cartilage ends.

The authors suggest that this is not a particular syndrome but due to some intrauterine disturbance. —*George L. Sackett, Jr., M.D.*

Besse, Byron E., Jr., Dahlin, David C., Bruwer, André, Svien, Hendrik J., and Ghormley, Ralph K. Aneurysmal bone cyst. *Proc. Staff Meet., Mayo Clin.*, May 6, 1953, *28*, 249–255.

Aneurysmal bone cysts were first described by Jaffe and Lichtenstein in 1942. Since then, only a relatively few cases have been reported. It is believed that these lesions have been classified under other conditions, such as primary giant cell tumor, giant cell variant, subperiosteal giant cell tumor, ossifying hematoma, angioma and others.

Pathologically, the lesions have a thin expanded layer of subperiosteal new bone beneath which is a mass of blood filled spaces, separated by fibrous septa of various thicknesses. Multinucleated giant cells and spindle shaped stromal cells make up the solid part of the lesion. Some areas may resemble changes seen in fibrous dysplasia and others resemble giant cell tumors. Giant cell tumors can be differentiated from aneurysmal bone cysts in that they do not have the cavernous blood spaces, but do have a homogeneous cellular stroma, with numerous multinucleated cells. Simple bone cysts and fibrous lesions of bone lack the cavernous blood spaces.

Roentgenographically, the lesions have an expanded cyst-like appearance. They are usually eccentrically placed. The cortex of the expanded portion is usually absorbed, leaving a fine sharp rim of periosteal bone. Trabeculations may occur, giving a soap bubble appearance. Lesions of the long bones most frequently occur near the ends of the shaft, but usually do not involve the epiphyses. Flat bones may show expansion of both sides. The differential diagnosis includes malignant bone tumors, hydatid diseases of bone, myeloma, fibrous dysplasia, enchondroma, and expanded hemangioma of bone, and others. The most probable ones to differentiate aneurysmal cysts from are the simple bone cysts and nonosteogenic fibroma. Giant cell tumors rarely involve the vertebrae, except in the sacrum.

Aneurysmal bone cysts are thought to be benign. Simple curettage will usually cure the lesion. Bone grafting may be needed. Radical surgical measures are unnecessary and it is questionable whether roentgen therapy is of value.

The authors present a case of aneurysmal bone cyst involving the second cervical vertebra in a ten year old girl. The diagnosis was suggested from the roentgenographic appearance and was verified by the pathologist following surgical removal of the cyst.

The authors re-emphasize that aneurysmal bone cyst is a distinct clinical, roentgenologic and pathologic entity.—*Charles W. Cooley, M.D.*

Paul, Milroy. Aneurysm of the popliteal artery from perforation by a cancellous exostosis of the femur; report of a case. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 270–271.

The case reported in this article is that of a man, aged twenty-two, who was admitted to the hospital because of a painful swelling behind the left knee which had been noted for seventeen days. The swelling was soft, fluctuant, warm and tender and did not pulsate. This proved to be an aneurysm of the popliteal artery. The artery was perforated by a cancellous exostosis which had led to the formation of a large saccular aneurysm.

The aneurysm was repaired by endo-aneurysmorraphy. The exostosis was removed at the same operation.—*Ralph S. Bromer, M.D.*

Heymann, Seymour; Kessel, I., Jackson, Harris, Javett, S. N., and Braudo, J. L. Septic arthritis and osteomyelitis in infancy. *J. Pediat.*, May, 1953, *42*, 561–569.

Six cases of septic osteomyelitis and arthritis in infancy are reported in detail. Four occurred in the neonatal period and the other 2 under eight months of age. The importance of early treatment to insure ultimate functional and anatomical recovery is stressed.

The course of the disease is rapid and there may be no fever or constitutional symptoms. No portal or entry could be found for the infections. The involved areas were tender, red and swollen—1 case had a pseudopalsy.

Early no bone changes were seen in these patients but soft tissue swelling was present in every instance and 2 infants had edema of the musculosubcutaneous plane. The lesions were near or in the joint. Roentgen findings included slight osteoporosis with blurring of the trabeculae or only soft tissue swelling, followed later by periosteal reaction. Two patients had bone destruction on the initial roentgenograms, 1 with several sequestra.

Follow up studies in 2 patients revealed slightly enlarged epiphyses and irregularity of the trabecular pattern with deformity of the bones.—*Martha Mottram, M.D.*

Junge, H., and Heuck, F. Die Osteochondropathia ischiopubica; gleichzeitig ein Beitrag zur normalen Entwicklung der Scham-Sitzbeingrenze im Wachstumsalter. (Ischiopubic osteochondropathy; with a contribution to the normal development of the ischiopubic junction during the period of growth.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, June, 1953, *78*, 656–668.

The authors have tried to decide whether roentgen changes of the ischiopubic synchondrosis, originally described as "osteochondritis ischiopubica" by van Neck in 1925, represent merely a normal stage of development, an inflammatory disease, or an aseptic necrosis.

Of 358 children, aged eight to eighteen, 50 showed unusual appearances of the synchondrosis, consisting of fusiform enlargement of this junction combined with irregular ossific centers, enlargement without alterations of ossification or thickening of the bone at this level. On the basis of their observations the authors believe that all these changes may occur in healthy children as a variation of normal ossification. They may also be caused by unequal distribution of body weight and have been recorded on the side opposite a lesion of the hip joint, subsiding as that lesion heals.—*Albert Oppenheimer, M.D.*

Girdwood, William. Multiple cystic tuberculosis of bone (Jüngling's disease); report of a case. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 285–287.

The author quotes Turkish *et al.*, who pointed out that Jüngling in 1920 noted the following characteristics in cystic tuberculosis of bone: gradual onset during puberty or thereafter. Pain occurred early and was not severe. The small bones of the hands and feet were affected. Cystic degeneration was seen on roentgenographic examination. No involvement of the periosteum or joints was present. Often there was involvement of skin in the affected area (sarcoid). No tubercle bacilli were discoverable. Tuberculous skin tests were usually negative. Histologic examination showed epithelial and lymphocytic cells and occasional giant cells, but no caseation or tubercle bacilli. The disease took a slow course, tending to spontaneous improvement and even recovery. The reported cases of the disease in children had differed in that tuberculin skin tests were usually positive, guinea pig inoculations or cultures were not infrequently positive, caseation was occasionally noted. associated skin lesions were only rarely seen, the long hollow bones were sometimes involved, and, although local lesions had a tendency to heal, the patient died of generalized tuberculosis.

Roentgenograms of the patient in the case reported showed destruction of the metatarsophalangeal joint by a cystic trabeculated lesion. There was expansion of bone and good definition of the cystic spaces. Erosion with bursting of the shell of the cortex was possibly present only in one area. The lesion was diffuse, extending through the whole of the proximal phalanx and proximally to the middle of the metatarsal. Roentgenograms of the left hand showed similar but less extensive lesions of a cystic type in the first metacarpal.

The lesion of the foot was excised completely and a bone graft from the right ilium was inserted. The histologic features were those of a tuberculous dactylitis.—*Ralph S. Bromer, M.D.*

Wilkinson, M. C. Synovectomy and curettage in the treatment of tuberculosis of joints. *J. Bone & Joint Surg.*, May, 1953, *35-B* 209–223.

This paper is a report of the author's experience in the treatment of tuberculosis of the spine, hip and knee by combined constitutional, antibiotic and operative measures. The main object of operations on tuberculous bones or joints is to heal the local lesion. His purpose in this paper is to describe how far such operations have been successful, when combined with constitutional treatment and antibiotic therapy, in preserving joint function and reducing the time required for treatment. The results of partial

synovectomy, partial capsulectomy and curettage of necrotic foci in bone appear to be satisfactory. After such operations the tuberculous process is usually arrested and recalcification occurs. Partial synovectomy and capsulectomy alone seem to be beneficial in those patients in whom no major necrotic areas are seen.

A summary of the particulars in each patient is appended at the end of the paper and a few illustrative examples are mentioned more fully in the text.

In patients with tuberculosis of the spine, especially in the thoracic region and when perispinal abscess formation is a prominent feature, the treatment helps to ensure stable akylosis in the type of case in which it might otherwise not occur. In children with tuberculosis of the hip and in adults and children with tuberculosis of the knee it is usually possible to save the joint and to restore function, provided the joint has not been destroyed before treatment is begun.

The paper is illustrated with reproductions of roentgenograms of 7 of the cases.—*Ralph S. Bromer, M.D.*

Adams, John P., and Goldner, J. Leonard. Fibrous lesions of bone. *South. M. J.*, June, 1953, *46*, 529–536.

The authors present a descriptive study of various types of benign rarefied bone lesions containing fibrous tissue which frequently are difficult to recognize and properly classify. Included are nonosteogenic fibroma, ossifying fibroma and monostotic fibrous dysplasia with consideration of the unicameral bone cyst and the less common lesions of neurilemmoma, chondromyxoid fibroma and hyperparathyroidism. They also discuss the roentgenographic appearances of similar lesions in which there is usually localized loss of bone substance placed eccentrically in the bone shaft on the metaphyseal side of the epiphysis.

Complete surgical excision of all fibrous tissue and filling of the cavity with bone grafts is the recommended procedure when it becomes necessary to treat the fibroma or localized dysplasia.

An unusual case of multiple nonosteogenic fibromas in the lower extremities of a seven year old girl is reported in some detail and descriptions of the microscopic material are given.—*James A. Martin, M.D.*

Moseley, John E., and Manly, John B. Aseptic necrosis of bone in sickle-cell disease. *Radiology*, May, 1953, *60*, 656–665.

Sickle-cell anemia is characterized roentgenologically by various skeletal changes such as widening of the medullary cavities with thinnings of the cortices and coarsening of the trabeculae, osteoporosis, osteosclerosis, narrowing of the medullary cavity with thickening of the inner aspect of the cortices of long bone, cupping of demineralized vertebrae, and aseptic necrosis. These changes are thought to reflect the marrow hyperplasia and vascular thrombosis which occur in this disease.

The authors present 5 cases of sickle-cell disease showing aseptic necrosis of bone. Their studies on these cases indicate that there is no direct correlation between the severity of the disease and the occurrence of aseptic necrosis. In addition, aseptic necrosis may occur in this disease as an isolated roentgenographic finding, or may be associated with other changes.

In one of the cases, skeletal changes occurred in the presence of a normal blood count and hemoglobin.—*McClure Wilson, M.D.*

Miller, G. Die Knochenveränderungen bei der Neurofibromatosis Recklinghausen. (The bone changes in Recklinghausen's neurofibromatosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, June, 1953, *78*, 669–689.

On the basis of 41 observations, in 29 of which the diagnosis was confirmed by autopsy, the author classifies the bone changes occurring in Rechlinghausen's neurofibromatosis as localized, dysplastic, and generalized.

Localized bone changes are caused by the pressure of neurofibromatous masses which may be periosteal, subperiosteal, intraosseous or intramedullary. Periosteal and subperiosteal neurofibromas are rare. They may produce localized bone atrophy or bone sclerosis and may simulate calcifying hematoma by separating the periosteum from the bone, with subsequent ossification around the tumor. Intraosseous neurofibromas, being devoid of bone, appear as areas of rarefaction resembling bone cysts. They are rather common. Roentgenologically, they cannot be differentiated from nonossifying fibroma of bone. Both have the appearances of a bunch of grapes, usually with sclerotic borders. Intramedullary neurofibroma may cause pressure on the bone surrounding the marrow cavity. Only one such case has been recorded in the literature.

Dysplastic bone changes are of different varieties. Very rarely, destruction of the epiphyseal cartilage may arrest the growth of an extremity. More commonly, hypertrophy or hyperplasia is observed, with elephantoid malformations caused by plexiform neurofibroma, associated with either thickening or atrophy of the overlying skin. Congenital malformations may be either typical, constituting an integral, inherited part of the disease, or they may be atypical and isolated. Pseudarthrosis of the tibia, associated with a defective fibular shaft, for example, is a typical manifestation of the disease. Atypical and isolated malformations may occur in almost any part of the skeleton.

Generalized skeletal changes are of two types—

osteoporotic and osteomalacic. Porosis, or atrophy, was common in the author's material, It may cause widening of the meshwork of the diploic spaces, accentuation of the vertical markings in the vertebral bodies with increased concavity of their end plates, coarsening of trabeculations in the pelvic bones with reactive sclerosis of the acetabular rims, widening of the bony meshwork in the distal ends of the long bones, thinning of the cortical layer with coarse trabeculation of the bones of the foot, or lamellation of the cortical layer of the metacarpals. One of the most common deformities due to porosis involves the thoracic spine and leads to severe rotary scloiosis. Osteomalacia with Milkman syndrome may also occur. Its interrelation with neurofibromatosis is obscure.

The author believes that neurofibromatosis and polyostotic fibrous dysplasia are distinct entities and should not be considered as varieties of the same disease, since they differ in their gross anatomical, histologic and clinical characters, age and sex distribution, and hereditary traits.—*Albert Oppenheimer, M.D.*

Grewal, K. S., and Das, N. Myositis ossificans progressiva. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 244–246.

The authors quote Mather and Ryan who affirm that myositis ossificans progressiva occurs exclusively in the white race. Their case, being an Indian child, is therefore of interest. So far only 161 cases have been reported in the literature.

The case reported is that of an Indian male child, seven years of age, who complained of inability to open his mouth and of progressive stiffness of the back and limbs since infancy. The roentgen examination showed bone formation in the muscles of mastication, a bony ridge which was continuous, on the front of the right chest and abdomen. The sternomastoids showed bony changes. The great toes were shortened, the proximal phalanx in each was dislocated laterally and was without evident basal epiphyseal center. This may have been represented, however, by an anomalous center of ossification adjacent to or fused by cartilage to the first metatarsal bone. A piece of bone was removed from the ridge of bone on the right abdominal wall and bone formation occurred with added zeal.

The disease is really fibrositis ossificans progressiva for muscle fibers are not primarily ossified. Frejka, quoted by the authors, distinguished four types: (1) the usual type, slow and gradual in onset, occurs insiduously in early childhood into which category the case reported falls; (2) a type that begins with inflammation of some sort; (3) a type beginning with trauma: new bone forms with each injury; (4) bone formation after transverse lesion of the spinal cord (myositis ossificans neurotica), a distinct condition.

The disease is progressive, though liable to some waxing and waning. The hands and feet escape and the rest of the body becomes bony stiff. Death occurs from intercurrent disease or from chronic starvation due to ossification of the muscles of mastication. Removal of bony masses results in reappearance of new bone, often in increased amounts.—*Ralph S. Bromer, M.D.*

Golden, G. N., and Richards, H. G. H. Xanthogranulomatous disease of bone with polyarthritis; report of two cases. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 275–284.

As far as the authors can tell from the literature, the cases which they describe in the paper present a unique appearance, namely, rheumatoid arthritis, advanced cystic changes of long bones showing histopathologically a xanthomatous type of lesion, and in one case, enormous cystic swelling of the limbs with a histopathologic resemblance to bone cysts. In the first case, the unusual features were the extensive changes in several of the bones particularly the right ulna. In the affected bones there was destruction of the normal architecture which was so severe as to be reminiscent in places of a giant cell tumor. The two large cysts which were shown were both connected with joints affected by chronic arthritis. A third feature was the presence of xanthoma cells in all the lesions.

The authors made certain observations from the study of their 2 cases. Some of the xanthogranulomatous lesions in the first case exhibited zones of necrosis bearing at least a passing resemblance to that in the better known necrobiotic subcutaneous nodule now well recognized in certain cases of rheumatoid arthiritis. In the latter, however, necrotic foci are surrounded by a definite and characteristic palisade of radially arranged fibroblasts not seen so convincingly in the authors' case. In the second case, the degenerative features in the form of eosinophilic hyaline change in collagen, together with the vascular change in a lesion in the first case, were noteworthy, being reminiscent of the "rheumatic" and "pararheumatic" diseases. The more cellular regions in both cases, basically granulomatous and containing fat-laden cells, varying from medium sized histiocytes up to large "foam cells," bore a strong resemblance to the lesions described in the third or xanthomatous phase of Hand-Schüller-Christian disease. It must be remembered, they state, that the so-called "xanthoma" or "foam" cells are by no means pathognomonic of the lipid reticuloses, and similar structures are often observed in traumatic fat necroses of the breast, in the vicinity of old ovarian hemorrhages, in hydrosalpinx, and in degenerating colloid damage where hemorrhage has occurred.

It is the authors' belief that the phenomena demonstrated in their 2 cases of polyarthritis, accompanied by xanthogranulomatous lesions in adjacent bones and soft tissue, are not as rare as they seem.

Many cystic lesions are noted by roentgen examination which never come to detailed histologic examination and they believe the problem merits further investigation.—*Ralph S. Bromer, M.D.*

Laurence, W., and Franklin, E. L. Calcifying enchondroma of long bones. *J. Bone & Joint Surg.*, May, 1953, *35-B*, 224–228.

The appearance of a calcifying enchondroma in the roentgenogram is that of a sharply defined granular or flocculent deposit of dense calcium in the medulla in, or adjacent to, the metaphysis. Normal cancellous bone surrounds the calcium deposit and there is no change in size or shape of the bone nor is there any periosteal reaction. In recent years a number of such calcified enchondromas have been identified, as stated by the authors, at the Royal Sussex Hospital and one was explored. Microscopic examination revealed bone and cartilage embedded in blood clot. The bone trabeculae were in general well preserved. Only small areas of cartilage appeared normal and the rest showed degenerative changes of varying degree and small areas of calcification. No evidence of malignancy or inflammation was seen. A review of this and other similar cases was made to ascertain whether there were any special features that would enable the condition to be more readily recognized.

Five cases of calcifying enchondroma are described with illustrative roentgenograms. The condition must be distinguished from endosteal sarcoma, Brodie's abscess, and benign chondroblastoma of bone. The roentgen appearance of each of these conditions is described in the discussion of the differential diagnosis.

The authors quote Brailsford who stated that it is not unusual to see in the lower third of the medulla of the shaft of the femur collections of calcium. These are indications of healed inflammatory foci probably tuberculous in origin. In the authors' cases it was noted in every instance that there was no interference with the architecture of the bone, nor was there destruction of bone or new bone formation. The argument against Brailsford's supposition is to be found in the authors' own pathological findings.

The authors emphasize that in cases of doubtful diagnosis biopsy should be taken.—*Ralph S. Bromer, M.D.*

Blood and Lymph System

Paton, A., Reynolds, T. B., and Sherlock, Sheila. Assessment of portal venous hypertension by catheterisation of hepatic vein. *Lancet*, May 9, 1953, *1*, 918–921.

Myers and Taylor have described a method of estimating portal venous pressure by passing a catheter with an internal diameter of 1 mm. via an antecubital vein into a hepatic vein. The catheter is advanced to the periphery of the liver until it meets resistance about 10 cm. beyond the mouth of the vein. This is called the "occluded" position. The authors used this method to study portal venous pressure in patients with liver disease. The procedure is simple and safe and they believe it to be reliable. Values for the occluded hepatic vein pressure showed good agreement with those subsequently obtained from a portal vein radicle.

In their studies they found no significant difference between the oxygen unsaturation of the hepatic venous blood in patients without liver disease and in patients with cirrhosis. In portal cirrhosis the occluded hepatic vein pressure was always greater than in patients without hepatic disease. In the cirrhosis group a sharp gradient occurred between the occluded and free hepatic vein pressures. On the other hand, the occluded hepatic vein pressure was found to be normal in patients with extrahepatic portal hypertension, although the pressure in the portal tributaries was subsequently found in to be elevated greatly. Both occluded and free hepatic vein pressures were found to be normal in jaundiced patients with extrahepatic biliary obstruction who did not have biliary cirrhosis. The occluded hepatic vein pressure was also normal in patients with intrahepatic biliary obstruction and it was normal in 4 out of 6 patients who had infective hepatitis. High occluded hepatic vein pressure was found in patients with congestive heart failure due to rheumatism and cor pulmonale, and there was only a slight gradient between the occluded and free pressures.

It is concluded that theoretical objections to the method do not invalidate its use in the clinical assessment of portal hypertension.—*Arthur E. Childe, M.D.*

Leger, L., Gally, L., and Arvay, N. La phlébographie portale par injection intraparenchymateuse splénique transpariétale. (Portal phlebography by transparietal intraparenchymatous injection of the spleen.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, 1953, *34*, 322–324.

The authors in 1951 described their first experience with portal phlebography according to the method of Abeatici and Campi (see former abstracts in this Journal). They performed a series of animal experiments to ascertain that the procedure is harmless and then gradually employed the method in the human.

In the present article they report the short case histories of 5 patients in whom the method was successfully used. The injection in case of splenomegaly is made transabdominally into the lower pole of the spleen and if the organ is not enlarged transthoracically through the tenth intercostal space. The preferred opaque medium is 70 per cent diodone. After the necessary preparation, a few centimeters of this

solution are injected under fluoroscopic control and when it is found that the opaque substance stagnates at the end of the needle proving that the splenic parenchyma has been entered, the rest of a 20 cc. amount is injected as rapidly as possible without, however, exerting undue pressure. Serial roentgenograms are made at various intervals showing passage of the opaque medium through the splenic vein into the portal system depending on the contracting power of the spleen.

The injection is entirely without pain and withdrawal of the needle is not followed by hemorrhage. In the few cases in which subsequent operation was performed, there was no evidence of subcapsular or intraparenchymatous hematoma. Interestingly, the accidental intraperitoneal injection of the diodone likewise remained without untoward effect in animals as well as in the human.

The authors reviewed the few articles reported so far in the literature and were able to collect 20 additional cases in which the method was used with satisfactory results.

They believe that at this early stage of the clinical application it already can be said that portal phlebography via transparietal injection of the spleen is of definite value in contemplated operations for portal hypertension and splenomegaly to determine beforehand whether the obstruction is located intrahepatically within the portal trunk or in the splenic vein. It is possible that with increased use the method may also acquire importance in the detection of liver metastases, especially in cases of cancer of the digestive tract.—*T. Leucutia, M.D.*

Cooke, Jean V. Chronic myelogenous leukemia in children. *J. Pediat.*, May, 1953, *42*, 537–550.

This is a review of 15 cases of chronic myelogenous leukemia in children aged four months to twelve years, representing 5 per cent of all leukemias seen in children in a twenty-one year period. There were 11 boys and 4 girls. The diagnosis was based on the relatively long duration of the disease, the absence of acute symptoms and enlarged peripheral lymph nodes, the splenomegaly and the leukocytosis with the presence of granular cells, including young forms. In 6 infants, in addition to the above findings, there was a tendency to anemia and hemorrhage.

Four older children had no treatment or only occasional treatment and the duration of the disease was one to two years.

Three children had well supervised roentgen therapy, which was given for the splenic enlargement and not the high white blood cell count. The total duration of the disease in these children was 4 to 5½ years. Terminally all had leg and thigh pain with slight rarefaction of the bones on the roentgenograms, followed by toxicity, asthenia and fever.

One child had treatment with urethane in the second year of the disease and died with an acute leukemic blood picture. Another child received radioactive phosphorus with little effect and died with hemorrhagic manifestations. The course was much shorter in these children than in those who received roentgen therapy.

The author suggests that irradiation should be used with divided doses for the enlarged spleen, asthenia or other disabling symptoms rather than the hyperleukocytosis.—*Martha Mottram, M.D.*

General

Knowlton, Abbie I. Cushing's syndrome. *Bull. New York Acad. Med.*, June, 1953, *29*, 441–465.

The author of this excellent review has recently published a summary of 33 cases of Cushing's syndrome from the Presbyterian Hospital (New York) series of 38 patients, plus an evaluation of 189 other cases previously reported in the literature (*Am. J. Med.*, 1952, *13*, 597–614). There has been revival of interest in this rare condition because the prolonged administration of ACTH or cortisone may cause its simulation in every detail.

Etiology. Since 1935 it has been maintained that almost all patients show a characteristic change in the pituitary basophiles (Crooke's hyalinization), probably a nonspecific secondary change which can be found in other varieties of hyperadrenalism, notably in virilizing syndromes. Based on this ubiquitous finding, 98 cases from the literature have been tabulated, suggesting combined involvement of the pituitary and adrenal glands in 29 different possible combinations of pathological lesions, all associated with the same clinical syndrome.

Among these 98 patients, 58 have had diffuse *adrenal hyperplasia* and 31 showed *basophilic pituitary adenoma;* 24 of them had both lesions co-existing, representing the most common combination. It may be noted that diffuse adrenal hyperplasia was found in over half the patients, while pituitary basophilic adenoma was found in about one-third. Additional varieties of pituitary tumors raised the incidence of pituitary lesions also to about half of all patients, however.

Benign unilateral adrenal tumors were found only rarely—11 times—and the incidence of *adrenal carcinomas* was the same.

Clinical Features. The disease is primarily found in young female adults. The classical history of rapid development of *obesity* is not elicited in all patients "but in each instance, whatever the overall change, there was a redistribution of tissue to give the characteristic facial and truncal obesity." Obesity was not usually painful, as claimed in Cushing's original case.

Although 70 per cent of patients do develop the important purple or red skin striae peculiar to the syndrome, other *skin lesions* are even more preva-

lent—acne, fungous infections and pigment patches. Previous reports have not stressed these findings, possibly because they were not deemed worthy of mention.

Hypertension, without a high incidence of eye-ground changes, is found in about 90 per cent of patients, with impressively high diastolic levels. This hypertension is remarkable because it is often completely reversible during treatment, even after many years' duration.

Gonadal function is suppressed in most patients, although one woman was found to be six months pregnant during a re-evaluation for progressive disease four years after the initial diagnosis.

Hirsutism is common (about 70 per cent), but *virilization* is extremely rare (5 per cent) and its absence helps to differentiate Cushing's disease from adrenogenital syndrome.

Mental abnormalities of varying severity occurred in 66 per cent of the Presbyterian Hospital patients, and 26 per cent were severely depressed, paranoid or confused. Although other series show only half this incidence of personality change, the author feels that its uniform clearing during remission of metabolic abnormalities must label it an important part of the syndrome.

Poor wound healing or severe infections occur in 30 to 40 per cent, representing a major threat to survival.

Headaches occur in two-thirds of patients and not necessarily in those with pituitary adenomas.

Purpura and easy bruising were found in 58 per cent of the author's series but reported in only 23 per cent of the cases of other authors.

Of the symptoms enumerated above, the most significant threats to life are: prolonged hypertension, abnormal personality, and poor resistance to infection. Fortunately, the ACTH- and cortisone-induced cases do not appear to develop hypertension so invariably, unless there is some underlying renal disease.

Laboratory Findings. These are by no means dependable as diagnostic criteria, except for the 94 per cent incidence of *diminished carbohydrate tolerance* in the author's group of 38 cases (and only 9 patients with overt diabetes). Average fasting blood sugar may be normal, so that a glucose tolerance test must be done. Diabetes is usually mild when present, with only one case of diabetic acidosis reported in the entire literature.

Urinary corticoid excretion is elevated, but not in all patients. Current techniques of determination may well be inadequate. Although *17-ketosteroid* excretion has been normal in this series as averaged to date, the author indicates that Jailer has postulated a new test to indicate the possible underlying pathological lesion: if the patient is given cortisone, 100 to 200 mg. each day for a period of time, 17-ketosteroid excretion may drop if the adrenals are diffusely hyperplastic. But if the underlying lesion is an autonomous adrenal or pituitary adenoma, the excretion rate may not be affected by the drug.

Interestingly, *polycythemia* was only rarely present in the Presbyterian Hospital series.

Roentgen Findings: Three-fourths of the patients in the author's series showed osteoporosis of the spine; one-half had osteoporosis of the skull; and one-third suffered compression fractures of the spine. Since the disease occurs chiefly in young patients, these findings are very important in corroborating or suggesting the diagnosis. With Cahill's help, perirenal air insufflation was done in 29 of the author's cases. In 23, possibility of adrenal tumor was suggested. In this group, 18 were explored operatively or postmortem, and only 8 times was a local tumor found. However, no proved case of adrenal tumor was read falsely as negative. ("Edema in perirenal tissue" is possibly a disturbing factor in interpretation of films.)

Treatment. Since basophilic adenoma of the pituitary almost never produces local symptoms, the pituitary can only be primarily incriminated and attacked in that small percentage of patients with other or mixed tumor types which may show signs of expansion in the pituitary fossa. Therefore, in most patients the first logical approach is to the adrenal glands. Local benign adrenal tumors, though rare, may theoretically be removed with success, although 3 of 6 explored patients in this category died during the postoperative period, while the other 3 went on to complete remission of the disease. If diffuse adrenal hyperplasia is encountered, bilateral subtotal adrenalectomy may be tried but the results are not uniformly good.

Varying roentgen-ray dosages have been directed to the pituitary region in 20 of the author's cases. In 10 of these patients remission of the disease followed therapy, but in only 5 cases was the remission persistent up to the writing of this paper in October, 1952. The author has tried androgen therapy in large doses only twice, the results being difficult to interpret because of concomitant pituitary and/or adrenal irradiation. There is also an occasional spontaneous remission, such as suddenly occurred in one of his patients a full year following unsuccessful subtotal adrenalectomy and pituitary irradiation.—*Stanley M. Rogoff, M.D.*

RADIATION THERAPY

Rubenfeld, Sidney. Experiences with a rapid irradiation technic in oral carcinoma. *Radiology*, May, 1953, *60*, 724–731.

This is a study to determine the possibility of treating head and neck cancers with cancerocidal doses over as short a period of time as four to five days.

Techniques were established and by trial and error a time-dose treatment formula was chosen of 3,500 r delivered safely and efficiently in three to five days.

The resultant epithelitis reached its maximum between fourteen and twenty days, and usually healed by the thirty-fifth day. The epidermitis, maximal at twenty-one to twenty-eight days, often healed by the thirty-fifth day. Maximum mucosal reaction was reached about seven days before maximal skin reaction.

No undesirable sequelae have been observed up to three years after treatment. The author feels that tumors of the oral cavity, which are radiosensitive and radiocurable by conventional radiotherapeutic methods may be similarly controlled by smaller doses delivered over a shorter period of three to five days.

Cases, 2 in detail, are presented.—*Lynne J. Taylor, M.D.*

Welin, Sölve. Diagnostic radiological aspects of hypopharyngeal cancer. *Brit. J. Radiol.*, May, 1953, *26*, 218–223.

At Karolinska Hospital of Stockholm, Sweden, 510 patients with cancer of the hypopharynx, of whom 206 were men and 304 women, have been observed since February, 1940. This high incidence, with the greater proportion of women, is quite unusual. If the hypopharynx is divided by a plane passing through the superior border of the cricoid cartilage into an upper and lower portion, it was found that in the men the carcinoma was located in the upper portion in 148 instances and in the lower portion in 52 instances, whereas in the women the reverse was true, the figures being 74 and 212 respectively. In 6 men and 10 women the carcinoma involved the whole hypopharynx. The greatly increased ratio in carcinoma of the lower portion of the esophagus in women is attributed to the relatively more frequent occurrence of Plummer-Vinson syndrome in the female sex.

The carcinoma of the upper portion of the hypopharynx is usually well demonstrated by indirect laryngoscopy and roentgen examination is of value only as a complemental procedure in furnishing information about the lower border and the depth of the lesion already diagnosed. In carcinoma of the lower portion of the hypopharynx, however, roentgen examination constitutes the main diagnostic procedure and must therefore be carried out very carefully.

The author uses conventional soft tissue roentgenography and spot film exposures following the swallowing of a barium sulfate mixture (in the ratio of 5 parts of barium sulfate to 1 part of water). He pays great attention to the mucosal pattern which he studies in the posteroanterior and lateral views. If a maximum filling of the entire hypopharynx is desired, the patient is made to swallow as large a quantity of the opaque medium as possible in a single bolus and the exposure is made immediately after the swallowing. For relief study of the mucosal pattern of the hypopharynx, the patient is given under fluoroscopic control one or two tablespoonfuls of contrast medium and asked afterwards to make one or two additional swallowing motions so as to obtain an optimal coating of the mucous membrane.

In interpreting the roentgenographic findings, the author uses three planes of orientation: (a) the vallecula plane, (b) the Morgagni plane, and (c) the esophageal opening plane. The distance between these planes being equal, a suspected lesion noticed at a certain level in the posteroanterior view can easily be located at the corresponding level in the lateral view. The opinion is expressed that spot films of the mucosal relief pattern are of greater diagnostic value than conventional roentgenograms or laminagrams, especially in lesions of the lower portion of the hypopharynx. Several examples are cited to prove this contention.

Owing to the high incidence of sideropenic anemia in Sweden, the author routinely makes roentgenograms in the phase of maximum filling of the hypopharynx in all patients with the slightest complaint of dysphagia. This procedure permits the demonstration of the valvular webs or strictures characteristic of the Plummer-Vinson syndrome. Once the presence of the syndrome is established, the patient is re-examined at six month intervals, or sooner if the symptoms become worse. The series of patients in whom subsequent carcinomatous change was observed now includes ten. In every instance the tumor arose above or below the valvular stricture, showing that the mucous membrane of the entire hypopharynx and not only of the stenosed part is affected.

Spot films are also of definite value in the follow-up of patients with carcinoma of the hypopharynx after roentgen therapy in demonstrating the typical atrophy of the mucous membrane, late radiation sequelae and possible recurrence of the carcinoma.—*T. Leucutia, M.D.*

Hultberg, Sven. Radiumhemmet's method of treatment of hypopharyngeal cancer. *Brit. J. Radiol.*, May, 1953, *26*, 224–233.

The author follows the classification expounded by Welin (see above abstract) and divides the hypopharynx into an upper and lower portion. The upper portion comprises all carcinomas (the sarcomas are not considered) of the edge and the anterior surface of the epiglottis, of the aryepiglottic fold, of the arytenoid regions, and of the pyriform fossa. The lower portion contains the postcricoid carcinomas and those numerous carcinomas described by Ahlbom in 1941 which show a fusiform growth, with the center about the esophageal inlet at the level of the sixth cervical vertebra. The carcinomas of the laryngeal surface of the epiglottis are included among the carcinomas of the larynx proper, whereas the tumors

arising below the boundary of the esophageal inlet are placed in the group of carcinomas of the esophagus.

The treatment of carcinoma of the hypopharynx at Radiumhemmet has undergone several changes. Since 1943, external roentgen therapy has been used as the method of choice. Surgical removal even in the early stage as well as radium irradiation at short distances have been abandoned.

The author describes in considerable detail the technique of the roentgen therapy, by laying special emphasis on individualized dosage, exact beam direction and careful management of the patient's general condition.

Briefly the present procedure is as follows: The patient on admission is subjected to thorough physical and laboratory examination. In case of necessity, fluid and blood are given and iron is administered intravenously before the roentgen therapy is started. The site of origin, size and extent of the carcinoma are determined and marked out on the skin. A diagram of the cross-section of the neck at the level of the mid-portion of the tumor is then made and the intended tumor dose calculated. Formerly, one anterior, one posterior and two lateral portals were used for the purpose of cross-firing but, since severe myelodegeneration occurred in 13 patients, now cross-fire is directed only from the two sides of the neck by using two portals of 4 by 12 cm. on each side. The position of the field and the direction of the beam are determined by fluoroscopy at about 90 kv. with the same apparatus as a preliminary step to each treatment. The patient sits in a specially designed chair (Lundström) and with the aid of straps his head is kept immobile during the irradiation. Cones are provided which can readily be adjusted to the different sizes of the portals and to the curved skin surface of the neck. The treatment factors are: 170–180 kv., 0.5 mm. Cu plus 1 mm. Al filtration, 20 ma., 60 cm. focus-skin distance, 50 r per minute and a daily dose of 400–500 r with backscatter. One field is irradiated each day. A total tumor dose of 5,700–6,200 r is given in 28 to 32 days, the corresponding skin dose per field amounting to 2,600–3,000 r. It is of paramount importance that the patients receive sufficient nourishment and, in particular, fluids both during and after the treatment. A gastrostomy is avoided at all costs and a tracheotomy is performed only in case of emergency.

The results are tabulated for a group of 157 patients treated from 1939 to 1942, a second group of 165 patients treated from 1943 to 1947 and a third group of 65 patients treated in 1948 and 1949. The five year cure rate rose from 7 per cent to 14.5 per cent.—*T. Leucutia, M.D.*

Fried, Carl. Die Röntgenbestrahlung der Uveitis; klinische und experimentelle Ergebnisse. (Roentgen irradiation of uveitis; clinical and experimental results.) *Radiol. clin.*, May, 1953, *22*, 167–184.

The author since 1940 has treated 340 cases of uveitis of various etiology with small doses of roentgen rays. He also carried out a series of experimental investigations in collaboration with Alváro, da Silva and Maffei of the Medical School of São Paulo, Brazil.

The roentgen therapy was administered complementary to other established forms of treatment. Usually doses of 40 to 60 r were given at certain intervals, the technical factors varying slightly from time to time. The present procedure is as follows: 160 kv., 0.5 mm. Cu plus 1 mm. Al, 10 ma., 50 cm. distance, cone of 3 cm. diameter, 40 r per treatment, four treatments at four day intervals for a total dose of 160 r; in the very chronic cases sometimes the individual dose is raised to 60 r per treatment.

A group of 125 patients was systematically followed up for a period of more than six months and compared with another group of 50 patients with uveitis in whom no roentgen therapy was used. In the irradiated group a larger number of cases became symptom-free within two or three months than in the control group and the average duration of the disease was definitely shortened.

The experimental investigations consisted of artificial induction of uveitis by various means in guinea pigs. The infected eyes were then irradiated with similar doses of roentgen rays without the addition of other forms of treatment. It was demonstrated that roentgen therapy alone could produce a cure and that, compared with the nonirradiated artificial uveitis in the control animals, the course of the affection was milder and shorter. Ophthalmoscopic observations and histopathologic examinations of the sacrificed eyes revealed reactive vasodilatation with hyperemia as the cause of the anti-inflammatory effect of the roentgen rays.—*T. Leucutia, M.D.*

Ash, C. L., Peters, Vera, and Delaure, Norman C. The argument for preoperative radiation in the treatment of breast cancer. *Surg., Gynec. & Obst.*, May, 1953, *96*, 509–521.

This is an excellent joint study emanating from the Ontario Institute of Radiotherapy and the Department of Surgery, Toronto General Hospital. At this teaching center the problem of attempting to improve the results of treatment in breast cancer has been continuously approached as a combined responsibility of the surgeon and radiotherapist.

At the onset the authors used the Portmann classification and preoperative treatment was restricted to the Stage III or advanced cases, whereas the Stage II cases were treated by radical mastectomy followed by radiation therapy. Later a new classification of the disease was evolved, based for

the sake of simplicity on the presence or absence of retraction phenomena, since it was noted that in patients with no evidence of host reaction, as demonstrated by the presence of contracting fibrous tissue proliferation, the local recurrence rate was only 2 per cent while in those with the retraction phenomena it rose to 12.7 per cent. The authors present two tables in which their classification is compared with the Steinthal and Portmann classifications.

Three other tables give the results of the combined preoperative radiation therapy and radical mastectomy in a series of 116 cases, 80 of which fell into Stage IV grouping. Despite this high proportion of advanced cases, the five year survival rate remained at 40 per cent, and was almost identical with the 43 per cent survival in the group treated by postoperative irradiation, where 80 per cent of the patients fell into the earlier stages of I to III according to Richards' classification. There remained, too, an appreciable ten year salvage of 16 per cent in the entire group, and perhaps surprisingly enough 15 per cent of the Stage IV patients also survived the ten year period.

The authors present a very complete plan of their treatment in the different stages of breast carcinoma.

They now advise routine preoperative irradiation in Stage IV lesions, with the possible exception of very elderly patients. In view of the appreciable incidence of local recurrence in Stage III cases treated with postoperative irradiation (12.7 per cent), they tentatively extended the preoperative irradiation to include also those cases exhibiting retraction phenomena, which would seem to indicate infiltrating carcinoma at points of potential danger if surgical treatment were carried out without initial protection by reactionary perilymphatic fibrosis. It is quite possible that preoperative irradiation will be advised later for any Stage III lesion in which the axillary lymph nodes are clinically involved.—*Ralph F. Niehaus, M.D.*

Peters, M. Vera. Carcinoma of the breast, with particular reference to pre-operative radiation. *J. Canad. A. Radiologists*, June, 1953, *4*, 32–39.

The author reviews all stages of breast carcinoma and discusses the various treatment plans, both preoperative and postoperative, which are employed by the Department of Radiotherapy, Toronto General Hospital, with accompanying statistical analysis indicating the advantage of preoperative over postoperative irradiation.

The author states that the incidence of distant metastases in Stage I was 20 per cent within a ten year period following treatment, and that adequate radiation therapy practically eliminated extension via the lymphatics with the conclusion that the failure was due to hematogenous spread prior to or during treatment.

The greatest incidence of breast carcinoma was found in the menopausal group. With the normal physiology entirely dependent on the ovarian stimulation, any abnormal ovarian function was reflected in a correspondingly abnormal condition of the breast. Statistics show that the five year survival rate in carcinoma of the breast treated before and after menopause was greater than in those treated concurrently.

It is concluded that, with the exception of the stage of the disease, coincidence of the onset of the disease with the menopause was the most important factor influencing the prognosis of carcinoma of the breast.—*T. E. Padgett, M.D.*

Arneson, A. N. An evaluation of the use of radiation in the treatment of endometrial cancer; Seventh James Ewing Memorial Lecture. *Bull. New York Acad. Med.*, May, 1953, *29*, 395–410.

The author in 1938 began the use of preoperative irradiation in endometrial cancer at Barnes Hospital and at the Barnard Free Skin Cancer Hospital.

In most instances a course of external roentgen therapy was given first. In the attempt to avoid intestinal sequelae, the dose in the operable patients has been reduced to about two-thirds of that generally employed in cervical cancers. Modifications in technique and in dose were made from time to time, but most of the patients now available for five year statistics received approximately 1,500 r (air) to each of four fields measuring 10 by 15 cm. The patients treated by irradiation alone received about 2,400 r (air) per field. The radium was inserted near the end of the roentgen treatment, using one application in the operable cases and two or more in those not to be operated upon.

The author has reviewed the primary cases given definitive treatment during the years 1930 to 1947 and, in this lecture, presents the survival rates expressed in relative values. Patients first treated elsewhere, or those given only palliative irradiation, and all private cases are deleted.

He discusses in detail the influence on the survival rates, which are carefully compiled in tables, of the following factors: difference in results with and without preoperative irradiation in case of hysterectomy in the clinically operable patients; effect of radium technique by using an intrauterine tandem or multiple capsules; influence of uterine size, a measurement of 12.0 cm. or more in depth of the uterine cavity being arbitrarily taken as enlargement indicative of extension outside the uterus; relation to histopathologic appearance; and disappearance of the tumor within the uterus following preoperative irradiation as demonstrated in the surgical specimen at the time of the hysterectomy.

The author states that the analysis of the results in his series of patients does not specifically clarify

the confused and fluid problem of preoperative irradiation for the treatment of endometrial carcinoma. He believes that the natural history of endometrial carcinoma mitigates against a survival rate in excess of 65 per cent for hysterectomy alone in clinically operable patients. The most important factors known to influence the prognosis are the clinical stage of the disease, the size of the uterus and the degree of differentiation of the tumor cells. The prognosis is excellent in early lesions which are well differentiated and occur in uteri of normal size. If, however, the uterus is enlarged or the tumor undifferentiated, the probability of cure by hysterectomy alone is about one in three. In these instances the use of preoperative irradiation will double the expectancy for survival. With carefully planned preoperative irradiation, consisting of a combination of external roentgen therapy and multiple intrauterine radium capsules, one can expect disappearance of tumor within the uterus in about three-fourths of all patients treated. Survival in these patients is on the order of 85 per cent.—*Ralph F. Niehaus, M.D.*

Tod, Margaret, and Meredith, W. J. Treatment of cancer of the cervix uteri—a revised "Manchester method." *Brit. J. Radiol.*, May, 1953, *26*, 252–257.

The authors in 1938 described a technique for the radium treatment of cancer of the cervix uteri which since then has generally come to be known under the name of the "Manchester method." Its three main features were: (1) the use of points A and B for dosage specification, point A being located "2 cm. lateral to the central canal of the uterus and 2 cm. up from the mucous membrane of the lateral fornix in the axis of the uterus" and point B, 3 cm. lateral from the former at the same level; (2) the introduction of vaginal "ovoids" of three sizes (2, 2.5 and 3 cm. diameter) and of flanged, thin rubber intrauterine tubes of three lengths for "a clinically convenient and physically desirable" application of the radium sources; and (3) the use of a "unit" system of loading of the vaginal ovoids and intrauterine tubes so as to obtain a constant ratio of the vaginal and intrauterine contribution to the dose at point A regardless of which combination of the applicators is used. The types of loadings originally suggested are shown in Table 1.

On the basis of experience gained with the treatment of more than 4,000 cases of cancer of the cervix uteri, the authors in the present article propose certain modifications of the former technique with the aim of increasing its accuracy.

First, the location of point A is reconsidered. Owing to the fact that either the cervix is eroded away or the lateral fornices are invaded by a fungating mass, often it is very difficult to establish the true anatomic relationship of these structures. Numerous observations by means of roentgenograms

Table I

Intrauterine applicators (figures from left to right, fundus to cervix)		
Long applicator	3 radium tubes	2-2-1 units
Medium applicator	2 radium tubes	2-1 units
Short applicator	1 radium tube	2 units
Vaginal ovoids (in pairs across the vagina)		
Large ovoids	5 units each	
Medium ovoids	4 units each	
Small ovoids	3 units each	

taken in the anteroposterior and lateral views immediately after the insertion of the radium have shown, however, that in the average case the lower end of the radium tube in the cervical canal is level with the lateral fornices, as indicated by the position of the ovoids. Therefore, point A is more conveniently located, without changing its original definition, by measuring "2 cm. up from the lower end of the last intra-uterine tube and then 2 cm. laterally in the plane of the uterus."

Secondly, a new method of loading of the applicators is suggested by retaining the "unit" system. In the original method the average ratio of the dose from the intrauterine and vaginal applicators at point A was 1:1, whereas the dose rate with the applicators of different size and length varied as much as 15 per cent on either side of the mean. In the new method, the ratio of the intrauterine to vaginal contribution is changed to 1.6:1 (the same as in the Stockholm method although arrived at by different approach) and the dose rate is made more constant for all the combinations of the applicators. The contribution from the vaginal ovoids to point A depends in both methods entirely on their effective radium content and not on their physical dimensions. The contribution from the intrauterine tubes, however, in the original method depended not only on the radium content of the constituent containers but also on their total length and to a lesser extent on their active length. To reduce the varia-

Table II

Intrauterine applicators (left to right, fundus to cervix)		
Long applicators	3 radium tubes	6-4-4 units
Medium applicators	2 radium tubes	6-4 units
Vaginal ovoids (in pairs across the vagina)		
Large ovoids	9 units each	
Medium ovoids	8 units each	
Small ovoids	7 units each	
Non-standard treatments		
(a) Short intrauterine applicator—1 radium tube, 8 units		
(b) Vaginal ovoids used in "tandem" are loaded as above		

tion in the dose rate at point A to a minimum, the authors now specify that the total length of each constituent tube shall be 2 cm. and the active length 1–1.5 cm. The types of loadings most apt to give an "ideal" system are shown in Table II.

The number of milligrams constituting a "unit" depends on the dose rate desired, *i.e.* on the total dose and over-all treatment time.

The authors include two additional tables, one indicating the dose rates at point A from the various types of "ideal" loadings listed in Table II and the other showing the adaptation of the system for loading with standard British radium tubes or other tubes available. The system is also adaptable to loadings with cobalt 60 sources.—*T. Leucutia, M.D.*

RADIOISOTOPES

Dobyns, Brown M., Vickery, Austin L., Maloof, Farahe, and Chapman, Earle M. Functional and histologic effects of therapeutic doses of radioactive iodine on the thyroid of man. *J. Clin. Endocrinol. & Metabol.*, May, 1953, *13*, 548–567.

The authors analyzed 25 cases of hyperthyroidism which were treated with therapeutic doses of radioactive I^{130} and I^{131}. The average dose of I^{130} was 25 millicuries and of I^{131} 10 millicuries. An additional 4 patients were studied who were euthyroid at the time therapy was given. The cases were drawn from a series of over 400 patients who were treated with radioactive iodine in the Thyroid Clinic of Massachusetts General Hospital. In the above 29 cases, thyroid tissue samples were obtained by biopsy, thyroidectomy, and from necropsy. The range covered from two days to eight years after treatment.

Functional Effects. It was observed that, as the clinical status of a patient improved, the uptake of tracer doses of I^{131} approached normal values. The change usually occurred in two to five months. Some cases did not reach normal levels until twelve months or more after therapy, or long after radioactivity could be detected. It was suggested that the maximum dose of radioactive iodine had a lethal effect on thyroid cells, resulting in hypothyroidism in two to three months.

Histological Effects. There was a wide range of tissue response to the irradiation. In some cases, there were minor changes and in others there was marked destruction, with replacement with scar tissue. Ten cases of the 25 showed no gross or histologic changes attributable to the irradiation. Gross changes, such as telangiectasis, atrophy, and adherence to adjacent structures were noted in some cases. Microscopically, the nuclei were irregular in size and shape. The chromatin material was bizarre, and the cell height was variable. Fibrosis, interspersed with groups of acini containing the bizarre nuclei and irregular cells, seemed to be characteristic of irradiation injury. Autoradiography showed that some of the acini containing the bizarre nuclei and irregular cells were capable of collecting the radioactive iodine, indicating that the cells were probably capable of producing thyroid hormone.

No thyroid carcinoma attributable to the effects of radioactive iodine was found in the 400 cases. Abnormal cells showing the typical effects of irradiation were noted in the case that was treated eight years previously. The problem arose as to whether the cells were eight years old or whether they represented mutants. The answer to the problem is speculative. Whether or not carcinomas will develop as a result of the radioactive iodine cannot be determined except by future observation in the treated cases.—*Charles W. Cooley, M.D.*

Gilbert-Dreyfus; Ambrosino; Zara; and Triantaphyllidis. Traitement de la maladie de Basedow par l'iode radioactif. (Treatment of Basedow's disease by radioactive iodine.) *Presse méd.*, June 27, 1953, *61*, 941–943.

As the use of this method is limited in France, a two year experience is reported. The use of radioiodine was considered contraindicated in patients who were young or pregnant or who had been receiving high doses of iodine; in the latter case the gland would not absorb any radioiodine. It was considered particularly indicated in severe cases, cardiac complications, cases associated with another severe disease, cases refractory to medical therapy which were unsuitable for surgery and in certain postoperative relapses.

The dose was calculated by means of the radioiodine uptake curve, which was obtained before each treatment. As the actual radioactivity in the gland was of interest, this uptake curve was not corrected for decay; the area under the curve divided by the area that would be obtained in case of 100 per cent fixation by the gland was designated as "biologic efficiency" of the administered dose. The product of this "efficiency" with the administered dose gave the effective dose, that is the number of millicuries utilized by the thyroid. The dosage varied greatly. Effective doses averaged 2 mc. in the mild, 4 mc. in the intermediate and 8 mc. in the severe cases. The dosage required increased with size of the gland in cases of similar severity, and it decreased with increasing age.

Of 100 patients, 62 were followed up for more than eight months. Of these 23 had a complete (biologic) and 23 only a clinical cure, 13 showed insufficient improvement and 2 showed myxedema; no parathyroid disturbances were noted. In 3 the treatment was not completed; of these, 1 showed significant aggravation of the exophthalmos. Clinical improvement, which sometimes was rapid, took place at the

latest after a delay of one month; clinical cures were obtained in two to six months. Relapses were frequently seen after apparent clinical cures and only "biologic" cures (*i.e.*, normal radioiodine uptake curves) gave real assurance of a good result. Determination of uptake curves was valuable not only in estimating the state of improvement but also in calculating the biologic efficiency of the subsequent dose if further treatment was required.—*Jonas Brachfeld, M.D.*

Tubiana, M., Dutreix, J., and Grinberg, M. Résultats du traitement de 115 cas d'hyperthyroïde par l'iode radioactif. (Results of treatment of 115 cases of hyperthyroidism with radioactive iodine.) *Presse méd.*, June 6, 1953, *61*, 807–809.

Using I^{131} obtained from Harwell, England, the authors have treated, since 1949, 115 cases of hyperthyroidism.

The radioactive iodine uptake was calculated six and twenty-four hours after the ingestion of the isotope. For a while the authors used uniformly a dose of 5 millicuries per patient. In a later series they administered a calculated dose of about 10,000 equivalent roentgens per patient.

A complete and durable amelioration of the symptoms was obtained in 66 per cent of the cases, of which 45 per cent were excellent results. Partial amelioration was noted in 18 per cent and no improvement in 11 per cent, whereas 5 per cent of the cases became transiently hypothyroid. Thus the results were favorable in general, especially as compared to antithyroid therapy and quite close to those obtained after subtotal thyroidectomy. Because of the simplicity of the treatment and the absence of immediate, untoward symptoms, this mode of therapy is second only to thyroidectomy.—*J. N. Sarian, M.D.*

McGirr, E. M., and Hutchinson, James H. Radioactive-iodine studies in non-endemic goitrous cretinism. *Lancet*, June 6, 1953, *1*, 1117–1120.

High uptake of radioiodine has been observed in thyroid disorders other than thyrotoxicosis such as nontoxic goiter of recent origin; in cretins with nonendemic goiter; following deprivation of iodine by blocking the utilization of iodine with antithyroid drugs; and by injection of thyrotropin.

The article presents a study of 12 patients with thyroid enlargement an typical features of hypothyroidism, varying in age from two years and nine months to twenty years.

The results emphasize how important it is that no laboratory test should take precedence over clinical assessment of the patient. Most of the amounts of I^{131} taken up by the thyroid gland and some of the amounts of protein-bound iodine found in the plasma suggested hyperthyroidism. These might readily, without reference to the clinical picture, have been interpreted as indicating thyrotoxicosis. The amounts of iodine excreted in the urine, however, were most consistent with hypothyroidism.

Other studies of cretins have shown evidence that the thyroid gland could not convert inorganic iodine into an organic form or that the gland could form thyroxine but could not release it into the circulation. This investigation shows that the patients studied could convert inorganic iodine to an organic form and release it into the circulation. It indicates that nonendemic goitrous cretinism may be caused by an inability of the thyroid to carry the synthesis of the thyroid hormone to completion, possibly because of an intrinsic familial defect.—*John F. Weigen, M.D.*